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GENERATING PLANT AT MADRID.

WE give illustrations of the type of engine and generator made by Messrs. John Fowler & Company, Leeds, England, for the Madrid Electricity Works. There are four sets of vertical engines of 500 indicated horse power, non-condensing. The last two sets put down are exactly similar to our illustration, but the first two sets, which have been working nearly three years, have the dynamos coupled to the end of the crank shaft on the low pressure side, and the details, of course, are somewhat altered to suit this arrangement, but the action of the valve gear is precisely the same; the governors, however, are driven by chain gear instead of gearing as in our illustration.

The cylinders are 20 inches and 36 inches by 21-inch stroke, 156 revolutions, boiler pressure 125 pounds, and are bolted upon very massive pillars, and connected together by a substantial casting, the exhaust steam passing over the top through an independent pipe from the high to the low pressure cylinders. This arrangement prevents the cylinders from being pushed out of plumb, and makes a thoroughly substantial job.

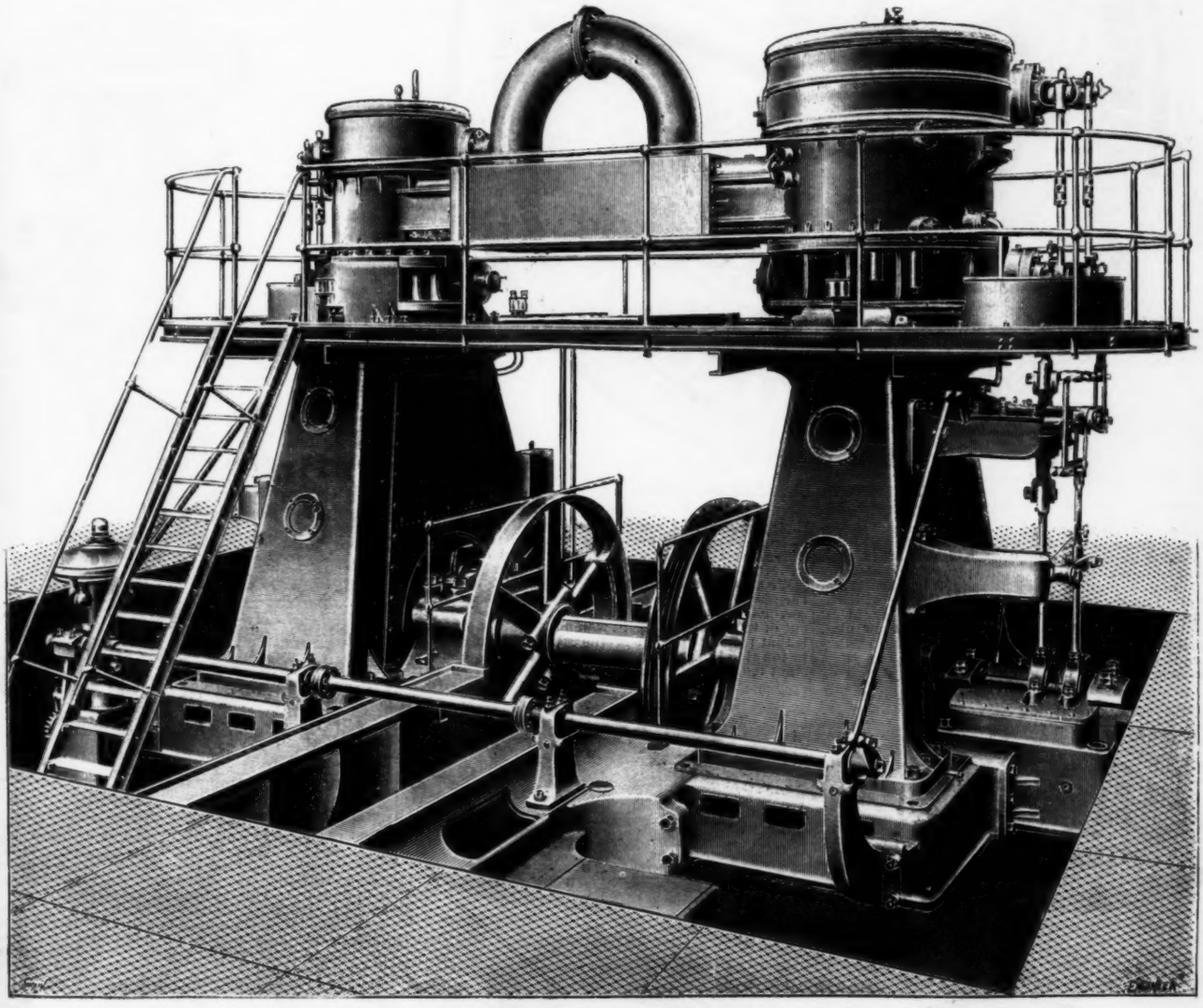
The cylinders are thoroughly steam jacketed, and are fitted with separate liners, the Corliss valves being fitted in the end covers, thus giving the smallest possible clearance for steam. The action of the valve gear can be best judged by the indicator diagrams which we give. One set was taken with about 600 indicated horse power load. We also show diagrams taken from a compound condensing engine made by Messrs. John Fowler & Company, with the same size gear when working light without any load. This shows the good cutoff that is got by the gear, whether light or loaded, condensing or non-condensing. The automatic positive gear is controlled by a vertical governor, which has given good results, and which we have referred to before upon former occasions. We illustrate Marshall's governor. These governors have been fitted to the steam alternators recently completed for the Corporation Electricity Works, Wakefield, by Messrs. Fowler & Company.

On November 14 of last year trials were run with one of the last plants put down for testing its efficiency; the consumption of water per kilowatt hour amounted to 33·4 pounds, the net indicated horse power being about 490, showing a combined efficiency of 82 per cent. On February 17 of this year a five hours' test was carried out by Mr. H. M. Sayers, the engineer and manager, upon one of the first plants of this type put down. The results we now give as follows:

Steam in boilers, 150 lb. reduced down to steam chests 125	
Total quantity of water fed into boilers,	25,819 kilos.=56,924 lb.
Total water condensed from separators on steam pipes and high pressure chest	6,786 lb.
Net water consumption	50,138 lb.
Mean kilowatts	297
Voltage	2,000
Water, per kilowatt hour	33·7
Coal, per kilowatt hour	5·79 lb.
Coal, bituminous nuts (Spanish)	54 per cent. fixed carbon
Volatile matter,	34·8 per cent.
Ashes	10·8 per cent.
Evaporation	6·62 lb. per 1 lb. coal
Boiler efficiency	61·8 per cent.

The whole plant ran perfectly cool, and free from any trouble from start to finish.

There are four 300-kilowatt Hall alternators, driven direct by four 500 horse power vertical engines. Each of the alternators is constructed to give its full output at a speed of 156 revolutions per minute, with a periodicity of 83 per second. The field magnets of the alternators form the fly wheel of the engine, and in two cases are placed between the high and low pressure cylinders of the engines, the foundation plate of which is arranged to take the alternator armature, which is slot or polar wound. The other two alternators are driven from the end of the engine shafts. The alternators have a very high insulating resistance, the coils being insulated with mica, and have resisted a piercing spark of 4,000 volts, the ordinary working pressure being 2,000. Both the field magnets which form the fly wheel and the armature which surrounds the same are extremely massive in construction, and are consequently capable of withstanding severe strains and variations of load which they are constantly put to.



COMPOUND ENGINES, MADRID ELECTRICITY WORKS.

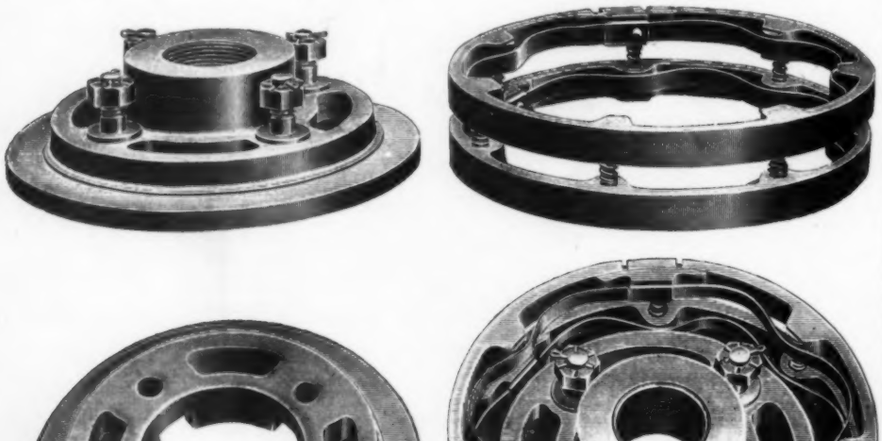
It is customary to run these four plants in parallel on the mains, and this they do perfectly satisfactorily without the intervention of spring couplings or any other device. It is found that with this particular type of alternator there is sufficient elasticity in the steam in the cylinders readily to take up any of the electrical balancing necessary in parallel running. The armatures are so constructed that they can readily be opened for cleaning and inspection, which is accomplished by means of a screw rack and gear, which draws

the armature apart on the planed face of the bed. The field magnets which form the fly wheel are built up of charcoal iron and have sixty-four poles. The armature core is also built up of charcoal iron, but has only thirty-two armature coils. These are so constructed that, in the event of one being damaged, it can be replaced by a new one in the space of a few minutes.

The arrangement of the governor is the outcome of considerable experience with an earlier form, and the experience gained, especially with engines when running in parallel for electric light work, has been satisfactory. It will be seen that the governor springs are preferably made in two lengths with right and left hand coils, and are fitted on the outside of the vertical stalk which is attached to the governor head. On the under side of this head a plate is held in position by screw pins, which take the push of the top side of the springs when the governor stalk or sleeve is lifted. The screw pins being secured in the top plate or crosshead by locknuts, this plate is fixed to the governor spindle and revolves with it. The top side of this plate receives the full power of the governor balls through friction rollers which are attached to the lever arms resting upon it, a steel plate being let in to reduce the friction to a minimum; by this arrangement the governor head is free to lift up or down by allowing the screw pins to pass through to suitable holes in the governor head. This governor has been adopted by Messrs. Fowler for all their engines, and we may mention that the steam alternators recently made and fixed by them for the Wakefield Corporation Electricity Works are fitted with these governors.

We also illustrate the piston. The principle is that the piston ring has a corrugated spring behind it, the corrugations being caused by internal bosses in and out of which the spring is wound, the effect of which is that the flat portion of the spring bearing on the piston ring is always at a sustained, definite, and constant tension, thus causing the ring which it supports to keep the cylinder uniformly steam tight. In addition to the spring just described, spiral springs are arranged inclosed in hollow bosses of one of the rings, so as to bear firmly on the blank boss of the neighboring ring, by means of which a spring bearing is obtained in both directions, viz., lengthways and across the barrel of the cylinder, each being independent of the other. This arrangement has been found in practice, we understand, to reduce greatly the friction of the rings upon the cylinder walls—quite 50 per cent.; and it also enables the extra vertical pressure upon the rings to be sustained without interfering with the free action of the rings to keep steam tight.—The Engineer.

300-KILOWATT HALL ALTERNATOR.

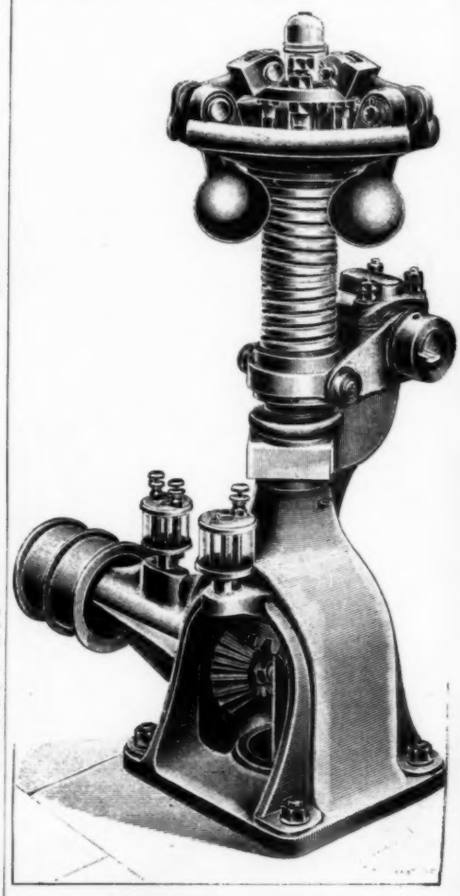


MARSHALL'S PISTON.

TROLLEY LIGHTERS FOR THE CHICAGO RIVER.

By ANGUS S. HIBBARD.

FOR some years it has been apparent to marine engineers and even to casual observers that the Chicago River is unfitted to provide harbor and wharfage for the growing commerce of the city. The size of steamships and barges engaged in lake traffic has steadily increased, and to-day a landing is effected at elevators or coal docks far up the stream with the greatest difficulty. Drawbridges cross the stream at frequent intervals, being at some points so close together that when open they form a continuous line down its center, impeding not alone the marine, but far more the land traffic, which waits, in long lines and blockades, the slow passing of some heavily laden craft. As a stream navigable for the purposes desired, the river is not a success, and in its interference with the land traffic of a great city may be classed as a public nuisance. Recent agitation of the question of river and harbor improvement has taken the form of recommendations to dredge it out once more, this time to a depth of 21 or 26 feet. Opposed to this has come, from a competent source, the recommendation to make a harbor in the lake for all shipping along the 6,000 feet of frontage now available, and so provide amply for anchorage, dockage, and wharfage of craft of any size. It was further recommended that the river be closed and covered and used from end to end as a boulevard. This plan was bitterly opposed, as tending to destroy the Lake Front Park and increase the congestion of traffic in the downtown district by the teaming of goods to and from the new lake docks. As a practical method of surmounting these objections, I have proposed a plan for preserving and increasing the utility of the Chicago River, which I will briefly outline.



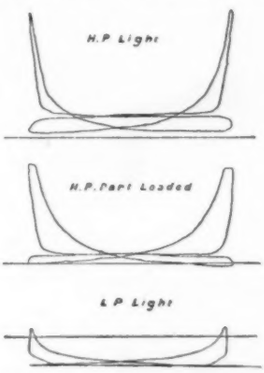
MARSHALL'S GOVERNOR.

I am in favor of an outside lake harbor for Chicago, with a breakwater or sea wall extending preferably as far as the entrance to the Calumet River at South Chicago. I believe it to be inevitable that the grain, the coal, and the greater part of the lumber shipped from and to this port must go to the Calumet River, where ample elevator and yard facilities may be had and where drawbridges interfere with the land travel of tens, or at most hundreds, instead of thousands of people.

Inside of the sea wall docks and warehouses may be built to provide for the loading and unloading of freight, which may be transported to or from the docks along the Chicago River to any part of the city in lighters propelled by electric power. I should propose for the river traffic four lines of double trolley wires,

two along the center and one along each dock. A broad, shallow lighter, say 100 feet long by 25 or 30 feet beam, with a screw wheel at each end and an electric motor at a point amidships, would provide ample carriage for freight of any description. It could attain a fair rate of speed in either direction, be steered from either end, and, with the clean, noiseless, and ample power provided, be made a handy boat for the purposes desired.

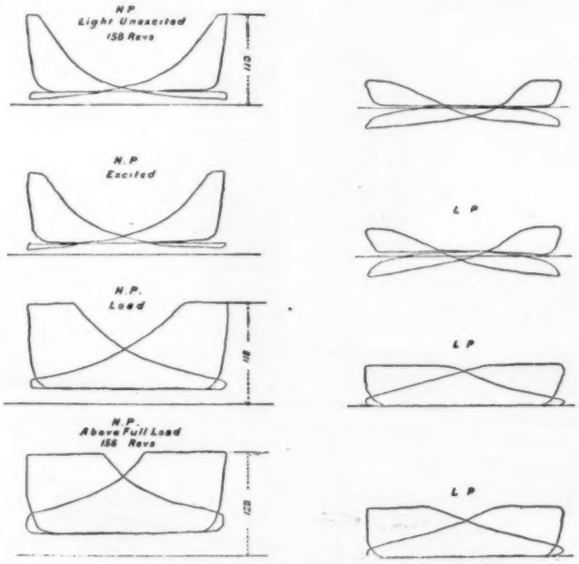
Such a lighter, loaded from a steamship or barge at anchor or from an outer dock, would first be towed to the entrance of the river. There connection would be made by the usual underrunning trolley, and power furnished to propel the boat at a fair rate of speed under bridges and to the desired dock. Here an overrunning contact and flexible cable would serve to carry the current until the boat was in place at the dock and tied up, when the cable could be pulled aboard. At the docks the motor could be used in various ways to furnish power to unload the boat, lifting package freight to the dock or onto trucks or hoisting it to upper floors of warehouses along the docks. In the same way lighters loaded at the docks would proceed to the river's mouth by electric power and there be towed alongside barges or steamships. Special lighters could be made to carry six or eight freight cars, thus carrying freight in carload lots either to the outer docks or vessels or to local docks in the city.



VALVE GEAR DIAGRAMS.

At the ends of streets abutting the river public docks could be established providing for handling freight to or from warehouses or mercantile establishments near by. By means of these and the trolley lighters, intramural transportation would be cheaply and readily effected. Coal delivered at yards in South Chicago could there be loaded on trolley lighters in wagon boxes, be transported by trolley to the docks nearest the point of delivery, and there, box and all, be hoisted to trucks and delivered with a minimum of teaming. In many other ways the river, on this plan, would be utilized and become a great water highway for the many instead of the few.

Ornamental, permanent bridges would cross at every street, serving for boulevards as well as for street railways, elevated railways, and ordinary street traffic. The teaming in and through the business center would be reduced to a minimum—a result which would do much to secure clean streets. The bridge nuisance would disappear, and with it the puffing, noisy tugs and boats, which do more to fill the air with smoke and grime than all other causes combined. From the lake park we should look out over a smooth sheet of water and, at a distance of half a mile or more, see rows of docks and warehouses, ships at wharves or at anchor, long lines of lighters being towed to and fro, and indeed the evidences of a busy commerce handled in orderly fashion, utilizing and conserving not alone the facilities in harbor and river afforded by nature, but availing of the advantages and economies to be secured from modern engineering. From an engineering standpoint it is certain that the results outlined can be accomplished. Are we to perpetuate the methods and the nuisances of the past or avail of the forces of today?—Western Electrician.



MARSHALL & WIGRAM'S VALVE GEAR DIAGRAMS.

"THE ENGINEER'S" ACCOUNT OF THE NAVAL BATTLE AT SANTIAGO.

ALTHOUGH we are not sufficiently well informed as to many of the important conditions under which the American and Spanish ships fought, enough has come to us to make some matters of conjecture clear. First, the promptness with which the American battleships moved is explained, for it is now said that it had been apparent to them that the Spanish ships were getting up steam, and consequently they did the same. Stated in this way, the matter is simple enough, but how came this about? It might be supposed that ships concealed in a harbor would have considerable advantage over those lying outside, and that aided by device there might be sufficient cover to enable them to get up steam unperceived by the enemy outside. Certainly it ought to have been apparent to the Spaniards that the American ships were getting up steam, and so had perceived their intention. It would need very peremptory orders indeed from home to prevent a certain amount of watching and making feints before leaving the harbor under such conditions. After some false alarms, the Americans might perhaps be caught unready. There seems opening for misleading an enemy under such conditions by burning wood or making smoke out of proportion to the expenditure of precious coal. Apparently, however, there was no thought of anything of this kind. The admiral did not seem to consider that was his business. "His was to do and die, his not to reason why;" but if this is what a government expects from an admiral, it not only courts destruction, it positively acts like a set of madmen.

The next question that suggests itself is that of artillery fire. Has any explanation been given of the total disproportion in the effect of the American guns to that of the Spanish? Admiral Cervera now tells us that the "Cristobal Colon" had no heavy guns. Now, this was the particular vessel that we believed could be reckoned on. We had already learned that the Spanish resources in the present day fall as far short of their supposed extent as in the days of the Peninsular war; but the "Cristobal Colon" had been purchased from Italy, and we imagined in a complete state, furnished with all the latest appliances, including two 10-inch new type guns and a powerful battery of ten 6-inch quick-fire guns. Does Admiral Cervera include these latter in the term heavy guns? The absence of the principal guns is too awful to call for comment; but if the 6-inch quick-fire guns existed, we do not understand why they did not make their mark on the enemy. What is true of the "Cristobal Colon" is true of the other ships in a less degree. The "Vizcaya" and "Oquendo" and "Infanta Maria Teresa" had together thirty 5·5-inch guns, and the ten carried by the "Vizcaya" were said to be quick-firing. Supposing all the principal guns to miss, it is difficult to understand how such a volume of shot as the secondary batteries discharge should prove so harmless. Following this comes the extraordinary fact that the American ships produced the most terrible effect with their fire. Except the "Brooklyn," they practically carried no quick-fire guns of the heavier and important class, which are mounted behind medium armor, and are, perhaps, the only quick-fire pieces which can be manned in close action. We can certainly recognize that efficiency and good gunnery tell tremendously even with slow fire, but that it should so entirely overpower the fire opposed to it without suffering from any blows argues absolute failure on the part of the enemy.

So far as we can learn, however, there were one or two modern improvements which the Spaniards possessed. Apparently, they had smokeless powder, and this just the one that might probably have been dispensed with advantageously under the circumstances. Nay, apparently, had they fired a quantity of blank cartridges which made a thick smoke, they would have done the Americans nearly as much harm as they did, and perhaps made it more difficult to deliver well-aimed fire at them. Again, the Spaniards possessed torpedoes, but instead of being fired at the enemy they seem to have lain on deck and formed mines for the enemy's shells to explode. The Americans appear to be satisfied that evidence is thus furnished to lead to the abolition of torpedoes on men-of-war. This may be the case; indeed, it has long been known that they constitute a source of danger; but we must not argue too confidently from what happened in Spanish ships, where things seem to have been in such extraordinary condition. We may readily admit that a torpedo constitutes a source of danger when it is left lying about among men in a state of chaos exposed to a heavy fire. It is painful to dwell upon the shortcomings of the ships manned so gallantly, but the greater part of the faults lie at the door of the government, not of those who came out so bravely to certain destruction.

Critics are disappointed in the lessons taught by the war, and they may well be so, for if we enumerate them they are surely not such as we ought to need. For example, it has been shown that (1) A small fleet ought not to go out to seek a harbor as the focus of war operations, and remain there until the enemy, hitherto scattered, muster in such force as to be able to crush it easily. (2) That under these conditions it is better that the admiral in command should have some discretion as to coming out to meet an enemy that is in such overpowering force. (3) To make a dash through a superior fleet, it is desirable to secure the lead in getting under steam. (4) It is no use reckoning on nominal superiority in speed if the bottoms of the ships are foul to an aggravated extent. (5) A ship loses in fighting power if she omits to take her principal guns on board. (6) Shot that only strike the water and make splashes produce no real effect on an enemy, unless he is strangely nervous, consequently even quick fire is no use unless well directed. (7) Under some conditions smokeless powder may be a disadvantage. (8) Torpedoes should not be left about exposed under a hot fire. (9) And by no means least, the whole success of naval operations depends on a trustworthy supply of coal. Did we need a war to teach us such things as these? Yet really at present we know of little else that has been brought out.—Engineer.

AMERICAN MACHINERY IN GREAT BRITAIN.*

THAT of late a considerable quantity of American electrical machinery has been supplied to the order of British customers is well known. That in some special branches the American manufacturer is in possession of greater experience, and therefore knowledge, than the British manufacturer, is admitted. But that American traction plants should find a market in Great Britain in competition with British production would appear to be the cause of much heart burning, and occasionally of not a little display of acerbity on the part of some who feel that their own work is being ousted. It is perhaps but natural that this feeling should be given expression to, for, after all, human nature finds it difficult to rise above the common lines, which are more or less selfish ones—rather more than less as a rule. British human nature is apt, too, to be of a somewhat pronounced and sturdy type. While the claim is made that love of the principle "Fair play and may the best win" is an innate national characteristic, yet it may be observed that there are some who reserve to themselves the privilege of "glorious inconsistency," as witness what occurs upon almost every occasion when the American competitor scores over his British opponents in tendering for electrical traction and other contracts. A wail of indignation and resentment arises from the disappointed ones, which, were it but based on just and business-like grounds, would be worthy of serious consideration. But what are the reasons behind his action? Does the British manufacturer decry the use of plant from across the Atlantic because it is of poorer and less efficient design than that made by himself, or because it has less skill and high class workmanship embodied in it than his own has? Well, no, not now; the days when such reflections could be uttered are past, for the very excellent reason that every British order filled by American manufacturers has been a practical refutation of such bogus charges. American machinery has been and is subject to the same tests prior to its acceptance; it has equally severe working conditions to contend with, and in addition is saddled with a far greater expense in transportation than is the case with British plant. In the face of this it competes, and that successfully, with all comers. Nor is it made by cheap labor; the American mechanic receives a high rate of wages, which is still high when compared with the cost of living. The British manufacturer either cannot or will not be induced to study the raison d'être of these facts, and, hating to see his own wares being supplanted, falls back upon sentiment for a battle cry. He appeals to the public to support "home industries," to give "employment to British labor," and so forth. But all the time he continues to offer an article that is becoming obsolete, or that is more or less crude, and if reproached on the former head, he, in effect, replies that it is as efficient as any that can be made, while in regard to the latter his answer is that he is not to blame, because the public will only afford him limited opportunities for manufacturing this semi-developed apparatus. It is but just to say here that the British nation is about the most obstinately conservative one in all Christendom; so there is some show of reason for the fact that the electrical manufacturer of the country has not aided to any great extent in the perfecting of traction systems. It is very evident that since the people have resolutely objected to the introduction of up-to-date methods until quite recently, often bringing forward ridiculous reasons to sustain their attitude of hostility, the manufacturers could hardly be expected to acquire much experience in such work.

Now that the public opinion has been, with great effort (put forth almost entirely by American, not British firms), swayed to the other side, and electric traction made to boom, it is nothing more than just and equitable that those manufacturers who have so largely helped to develop the knowledge of the subject in other countries should reap some of the fruits of their labors in this, which is commencing to avail itself of the pioneer work done elsewhere. But evi-

* From The London Electrical Review.

dently some British manufacturers cannot see the fairness of this, because, doubtless, from their point of view, "the boot is on the wrong foot." When the steam engine was made a commercial success, British engineers offered no objection whatever to the filling of orders from foreign countries. And the same in the case of the locomotive. At the present day they are happy to send such plant abroad as they are paid for, even to countries that could themselves manufacture it. When it so happens, however, that certain branches of electrical work are, at great expenditure of money and energy, perfected outside of Great Britain, and when those who are responsible for this advance are given British orders to execute, there goes up a dog-in-the-manger cry, the motives of which are only too apparent.

The truth underlying the whole matter is not difficult to point out. Given a public notoriously conservative on the one hand, and, to a certain extent, bound up in vested interests on the other, it can be readily understood that the advantages offered by electrical science will not gain a very rapid headway. These characteristics will, nevertheless, operate to insure permanency in any progress that is made. Clearly, then, it would have been good business for the British manufacturer to have striven, in season and out, to win over the public to a thorough appreciation of the benefits awaiting acceptance, and in so doing he would have created the opportunities for enlarging his own experience. Instead of throwing himself, heart and soul, into a propaganda of this nature, he has been content to proceed along in a leisurely and very dignified manner, with the inevitable result that others elsewhere have seen their opportunity, and, being of hustling, businesslike habits, have not been slow to grasp it.

Then again, although the British manufacturer has the advantage of low wages, cheap material, and very short distances of transportation, he either cannot or will not sell his goods on a level with his American rival. From this fact it is justifiable to infer one of two alternatives: either that an unduly large profit is looked for or that the workshop management is of a low order.

To sum up the conclusions rendered apparent by the foregoing, it may be concisely stated that the manufacturer of American plant is entitled to the support he is receiving in Great Britain (not to mention the British colonies) because he has very largely been the perfector of the highest and most satisfactory types of apparatus for traction and power purposes; because he has convinced the British public of the backward state of its urban and suburban transit facilities; because he has gained a knowledge and experience in the working of the most modern and satisfactory system of traction known, that few can equal, and finally, because he competes for this support under the condition which has for generations past been entwined into British business life; the purchase (other things being equal) in the cheapest market.

ROBINSON'S UPRIGHT SAWING MACHINE.

THE alternating vertical sawing machines employed for the cutting of round timber or large squared logs receive as many blades as there are kerves to be made. The two external blades are capable of effecting the squaring, while the others divide the log into boards, panels, or veneers. These machines are particularly recommendable for doing continuous work that does not require a frequent change in the number or spacing of the saw blades.

The accompanying figure represents a machine of this kind, devised and constructed by Messrs. Robinson & Son for an important exploitation of forests in Australia. This machine is very powerful, and is capable of sawing timber of all sizes up to a diameter of 5 feet.

The frame that carries the saw blades is made entirely of steel, and combines strength and rigidity with lightness, thus permitting of working with a relatively large number of saws without a rapid wear of the parts brought into play and without excessive vibration.

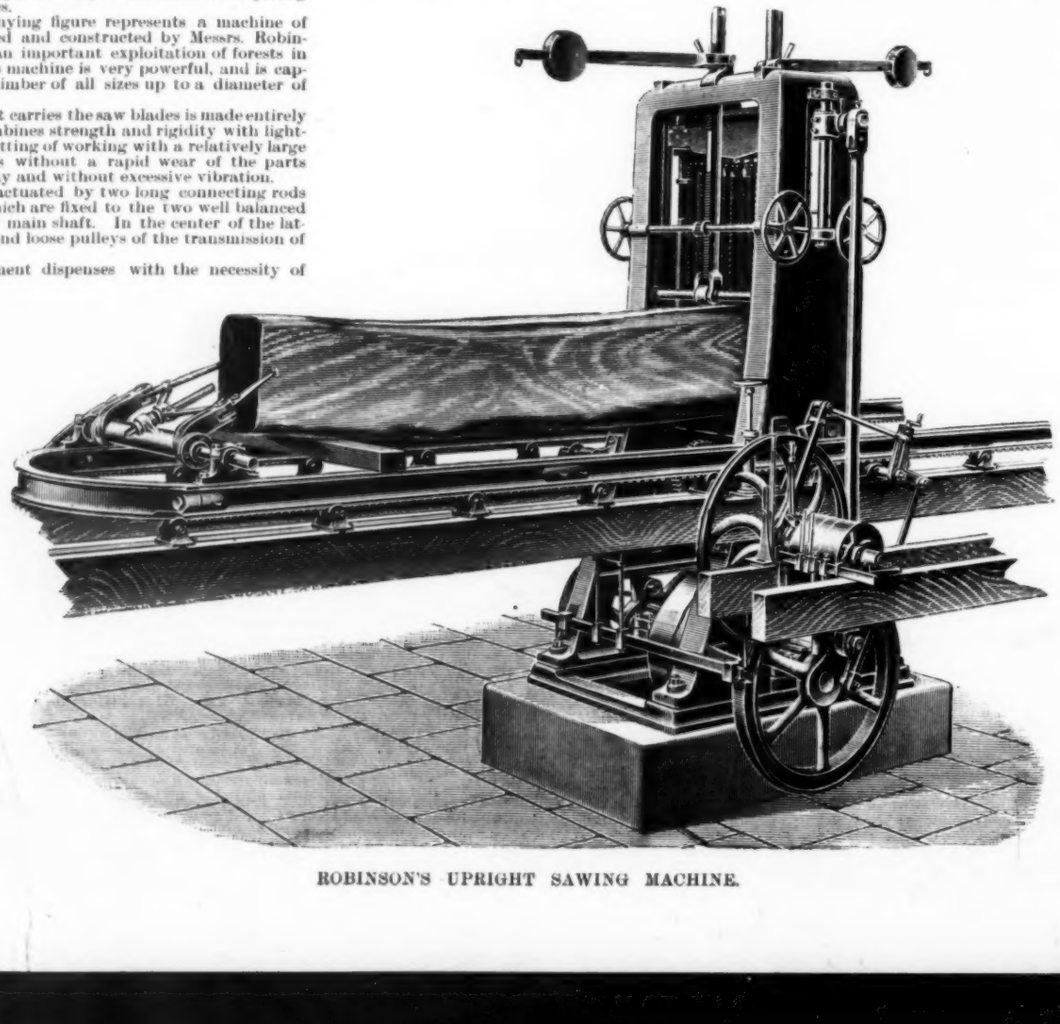
This frame is actuated by two long connecting rods the cranks of which are fixed to the two well balanced fly wheels of the main shaft. In the center of the latter are the fast and loose pulleys of the transmission of power.

This arrangement dispenses with the necessity of deep and costly foundations, and also renders all the principal parts of the machine interdependent.

The wood is borne by an iron carriage and held in position by regulatable dogs. A silent ratchet wheel, actuated by an eccentric on the crank shaft, acts during the sawing upon the rack of this carriage and causes it to move forward.

An independent transmission of motion permits of quickly moving the carriage back after the sawing is finished, and of bringing it promptly into contact with the blades after it has been charged with another log.

A machine constructed for the sawing of wood 5 feet in diameter and 30 in length makes 80 revolutions a minute, requires 12 horse power, and weighs about 15 tons.—Revue Industrielle.



ROBINSON'S UPRIGHT SAWING MACHINE.

THE CHAPMAN-HUNTER POCKET PITCHOMETER.

THE illustration above shows the Chapman-Hunter pitchometer, which is being put on the market by Messrs. Walker Brothers & Company, patentees' agents, of 44 Constitution Street, Leith. It will be seen from Fig. 1 that it is of very simple construction, small in size, of light weight, and unlikely to get out of order. Figs. 2 and 3 illustrate two methods of its application to determine the pitch of a screw propeller; the former when the propeller is lying on its end in the shop and the latter when it is on the shaft. There are, however, many other purposes to which the instrument is applicable, as it can be used to determine the angle of any object in relation to any other object; for example, it may be employed to show whether the screw shaft of a ship is at right angles to the piston rods.

The pitchometer consists of a bridge piece of steel

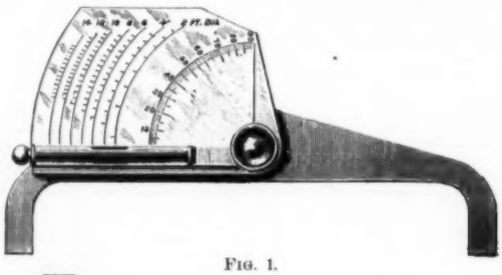


FIG. 1.

FIG. 2.

APPLICATION IN SHOP.

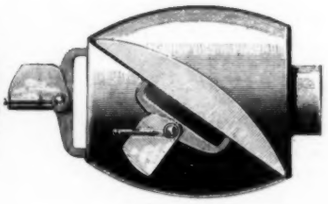


FIG. 3.

APPLICATION ON SHIP.

THE CHAPMAN-HUNTER POCKET PITCHOMETER.

with two ends or feet, to be applied to the object whose inclination is to be measured. On this bridge piece is a movable index plate, and a level, also movable, on the same center as the index plate. Both the index plate and the level can be separately clamped to the bridge at any angle in relation to each other.

The following is the method adopted in finding the pitch of a screw propeller: Lines are drawn on a blade at various radii from the center of the boss, say at 2 ft., 4 ft., 6 ft., 8 ft., 10 ft., 12 ft. and 14 ft. radius. Then, if the propeller be lying as in Fig. 2, the instrument is applied to the boss as shown. The level is first put to zero on the quadrant of degrees, and then both index plate and level are adjusted together to bring the bubble to the middle of the slot. The index plate is then clamped by the screw at the back, and the instrument transferred to the first pitch circle on the blade (Fig. 2). The level is set horizontally, and on its intersection

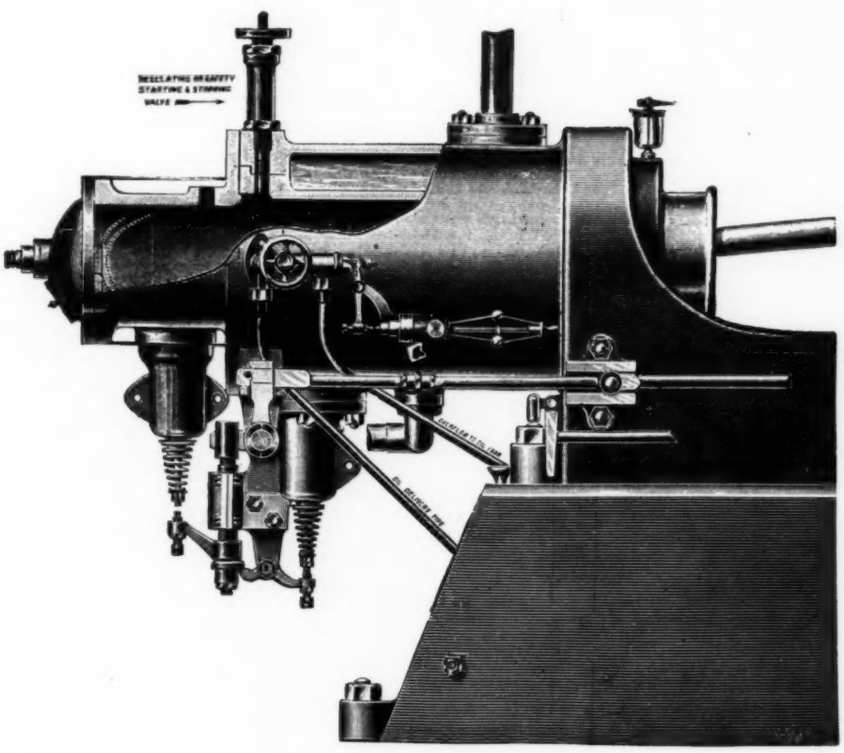
with the are marked "2 ft. dia." the pitch of the blade on that point can be read. The instrument is next transferred to the line of 4 ft. radius, and the process repeated, and so on at 6 ft., 8 ft., 10 ft., 12 ft., and 14 ft. radius, and thus the pitch is determined at several points.

If the propeller is lying as in Fig. 3, the operation is substantially the same, the only difference being that the index plate is placed at right angles to the bar or bridge. It will be readily seen that there may be other possible uses of the instrument besides that of measuring pitches, and that it is a very handy tool for the engineer, whether he be engaged on shipwork or not.—We are indebted to London Engineering for the cuts and copy.

THE ATLAS OIL ENGINE.

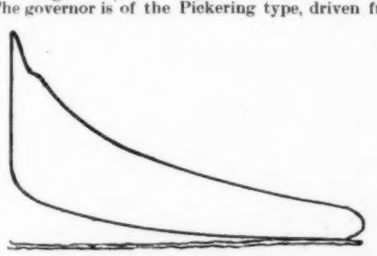
AMONG the successful oil engines that have been brought out during the past year, the "Atlas," of Messrs. Humphries & Company, of Pershore, is worthy of notice. The great variety of work for which an oil engine is suitable has hastened the development of this kind of motor, and the little attention required after once being started permits of it being placed in the hands of an unskilled person who is normally engaged with other work.

The Atlas engine belongs to that class in which the oil is injected directly into the cylinder, and the combustible charge is fired by a hot plate, whose temperature is maintained by the heat developed at each explosion. In the accompanying engraving the cylinder and combustion chamber are shown partly in section. In the end of the latter is shown by dotted lines the hot piston which fires the explosive charge. This piston is made adjustable for the purpose of using different kinds of oil, from the heavy Russian and American oils to common petroleum lamp oil, these different oils requiring varying amounts of compression for accurate firing. It will be noticed that the hot piston has an annular space behind it, so that only a very small portion of it is in contact with the combustion chamber cover, and consequently, due to an absence of radiation, it is easily maintained at a temperature high enough to fire the charge.



THE ATLAS OIL ENGINE.

The governor is of the Pickering type, driven from the crankshaft by a belt, and is very sensitive. The depression of the central spindle, due to the radial motion of the balls, pushes over an adjustable stud in the lower end of a vertical lever, the upper end of which terminates in a fork, which moves the spindle of the valve that regulates the supply of oil to the cylinder. By this means the intensity of pressure in the cylinder is regulated according to the load, by admitting more or less oil per charge, and thus the ordinary cycle (Otto) is never without an impulse. Such a method of governing gives great regularity at all powers, and at the same time preserves the temperature of the hot piston.



INDICATOR DIAGRAM FROM ATLAS OIL ENGINE.

The oil is stored in the bed casting, and a definite amount is pumped from thence to the cylinder by every downward stroke of a small pump plunger, situated at the bottom of the tank, so that it is always immersed in the oil which it is delivering. When running at less than full load the surplus oil is returned through the overflow pipe to the oil tank.

The pump plunger is worked by a rocking shaft and rod, which receives its motion from the pinion that works the valves. Unlike most other oil engines, the valves are not operated by cams, but by a rod connected to an eccentric pin in a pinion geared with another pinion half its size on the crankshaft. The other end of the valve rod slides between guides bolted to the engine frame, and gives motion to a rocking arm through an intermediate adjustable link. The rocking arm gives a reciprocating motion to a vertical spindle which lifts the air and exhaust valves.

At starting, the hot piston is heated by a small lamp using the same oil as the engine. This takes about ten minutes, after which the lamp is dispensed with.

The accompanying indicator diagram is a fair average of those taken during a five hour trial of a 7 brake horse power engine running full load. The following were the principal results obtained:

Indicated horse power	9·73
Brake horse power	8·4
Mechanical efficiency	86 per cent.
Oil consumption per brake horse power hour (Russoline)	0·76 pint.

We are indebted to our new English contemporary The Mechanical Engineer for the cuts and description.

THE UNEXPECTED, WHICH OFTEN HAPPENS.

PROF. JOHN E. SWEET delivered an address on this subject before the American Society of Mechanical Engineers some ten or twelve years ago. It was full of suggestiveness, and it is as timely to-day as it was when it was first read. The Locomotive in its April issue reproduces it, in part, below:

"If we had no experience or knowledge, or no knowledge of the experience of others, everything which happens would be unexpected. It is not so much the unexplainable as the unexpected which attracts our attention, excites our astonishment, or disturbs our mental equilibrium. The man who devotes his life to experimenting with practical mechanics is sure to meet with the unexpected, or else to be too wise for his generation. Some of us do not care to admit that we were ever caught with the unexpected, but I beg to expose a few of the many things that have come upon me unexpectedly, in the belief that they may be of use to others, and in the hope that others will explain their experiences, so that we may profit in return.

"Things perfectly familiar to mechanics engaged in one branch of industry are often matters of great wonder to workers in another branch. Men may work a lifetime in cast iron as applied to tools and machinery, and yet know nothing of what it will do in the heating stove of a blast furnace. To such a man the discovery that cast iron heating pipes grow from six inches to a foot in length by use would be unexpected. To tell the blast furnace man that certain core bars, used for casting pipes, changed their length by three inches in casting twenty or thirty pieces, would be no surprise, until you supplemented the statement with the fact, strange to him, that they grew shorter, rather than longer.

"The unexpected sometimes comes from causes that are perfectly self-evident after the thing has happened (as was the case in my experience by the clogging of a nail machine by scale from the nail plate), and at other times from causes utterly unexplainable, or from causes which are difficult to fathom. In practice, we use with a fair degree of success, for a piston rod packing, simply an easy fitting Babbitt bushing. When these bushes become worn so as to leak, we close them up by compressing them in the water cylinder of a sort of hydraulic press. In this operation a mandrel somewhat smaller than the piston rod is put inside, and, with all the pressure we can bring to bear, we have never been able to compress the bush so as to make it grasp the mandrel tightly, and yet in two or three cases, or, perhaps, in half a dozen, we have had these bushes (one of them after running a year) shut down while the engine was running, so as to grasp the piston rod as if it were gripped in a vise—in fact, so strongly as to break the bushes asunder, or so that we had to destroy them to get them off.

"The unexpected comes upon us both by things not working when we think they ought and by their working when common reasoning would indicate that they ought not. The man who first invented or constructed a lawn mower must have been considered an idiot, or at least a man not familiar with the common laws of mechanics, to have imagined that he could, with two light wheels, get traction enough to rotate a cylinder of six times their own weight, at six times their own velocity, and cut the grass in addition. The worm that drives the bed of a Sellers planer does not wear out half so fast as it ought, and I fancy there is something unexpected about it, even to the makers themselves.

"An engine with a 12" × 18" cylinder had been running a year at 185 revolutions a minute, standing quietly on a cut stone foundation. One day, without any apparent cause, it began to shake endwise, and before night had shaken itself loose, so that it had a movement of three-sixteenths of an inch at every turn. The engine being self-contained, no harm came to it, except the loosening of the foundation, and, as the work was of more consequence than the foundation, it was allowed to go on, with a view to repairing it at vacation time, a month ahead. But before vacation time came the shaking stopped without any more apparent cause for its stopping than for its beginning, and the engine continues to run quietly, to this day, notwithstanding the shattered foundation.

"The unexpected often happens to the scientist as well as to the practical man, and this must have been the case with Crookes, when he invented the radiometer. The story goes that he first invented the thing and then made it; but it turned out as tradition says the ship did when some genius blew into the sails with a bellows. It went the wrong way. We laugh at the stupidity of the man with the bellows, and the next generation may laugh at Crookes.

"An engineer put in charge of our electric light station found them using oil of 26 gravity for lubricating the engines and dynamos. Even when the oil was used freely, the bearings would warm up, and sometimes get hot. It was the practice to increase the quantity of oil as the journals got warmer, and to turn on water when oil would do no longer. To the engineer's surprise, he discovered, one night, that one of the bearings kept cool; and he noticed also that the oil cup was feeding only about one-quarter as fast as had been the practice. The happy idea of 'letting well enough alone' occurred to him, and he found that the bearing continued to run cool; and by experimenting he proved that by feeding little enough oil he could make the other bearings run cool also.

"For casting a chilled die, to be used under a drop hammer, old chilled car wheels were used, to which fourteen per cent. of spiegeleisen was added with the expectation that a good chill would be produced, as this had been our previous experience. The first surprise was to find that the die showed no evidence of chill whatever, but that it could be filed easily. Some pieces of work were required at once, and the die was put in with the expectation that it would serve only for a short time; but the second surprise came when its endurance proved to exceed the best of the chilled dies in the proportion of two to one.

"A large percentage of the unexpected comes in the development of original inventions. When these are in the experimental stages it is easy to brand the inventors fools or lunatics; but when predicted failures succeed, it is also easy to forget that we ever expected anything else. It is not always the ignorant who are wrong, or the best informed who are never in error. If ten [now twenty] years ago the possibility of conversing with people fifty miles away had been publicly suggested, it would have been accepted only by the ignorant, who, remembering the marvels that have been accomplished, would, in their blind faith, admit of its possibility, while the best informed would have been staggered at the thought. Less than ten [twenty] years have now rolled away, and it is an everyday occurrence.

"It is not always the uneducated, the insane, or the stupid who produce failures, nor the best educated, most thoughtful, or most experienced who bring out everything according to the original intention. The unexpected comes to the good and bad alike, and so, in our teachings to the young and our planning for ourselves, is it not well to have our statements and our speculations pretty well saturated with the elements of uncertainty?

"It is an old and common custom to use the statement that 'two and two are four' as an example of the certainty of certainties, and another that 'like causes produce like effects;' while as a simple matter of statement, the first can easily be shown to be twenty-five per cent. off, and the latter to hold along all the way from like results to results diametrically opposite."

Dr. Le Neve Foster, in his annual report on the mineral industry of the North Wales district, remarks that a centrifugal pump dredger has lately been set to work for bringing up sand from the bed of the Mawddach Estuary, between Dolgelly and Barmouth, with the object of determining whether gold can be extracted in paying quantities. The result of this experiment on a large scale will be carefully watched.

JAMES WATT AND THE DISCOVERY OF THE COMPOSITION OF WATER.*

When your secretary did me the honor to communicate the wish of the committee that I should deliver this lecture, he was good enough to send me a list of the names of my predecessors in the position I was invited to occupy, together with a statement of the subjects on which they had addressed you. I confess I read his letter with very mingled feelings. To be asked to form one of such a distinguished company was in itself an honor which I deeply appreciated. On the other hand, it seemed well-nigh hopeless to find any theme associated with the life and work of the great man whose services to humanity we are this day called upon to commemorate, that had not been dealt with by one or other of those who preceded me. Naturally, and as befits the subject, the greater number of those who have spoken on these occasions have been distinguished engineers and mechanicians, and they have been able to speak with a fullness of knowledge and a weight of authority on the outcome of the great engineer's labors to which I, who know nothing of engineering or machinery, can have no pretensions.

It occurred to me, however, on reflection, that there was one incident in Watt's career which, so far as I could learn, had not been handled by any one of those whom you have invited to appear here, and to which, as it comes within my own province, I thought I might venture, without presumption, to engage your attention. I was the more impelled to select it in that it illustrates one side of Watt's intellectual activity which those who regard him only as an inventor and a mechanician are apt to undervalue or lose sight of altogether. It serves, too, to throw additional light upon his mental character and moral worth, and thus enables us to form a fuller and more just appreciation of the attributes of the man we wish to honor. The incident, in a word, relates to Watt's share in the establishment of the true view of the chemical nature of water.

To the historian of science this is doubtless an old, old story, on which it would be difficult to say anything new. The literature concerned with it occupies many volumes, largely owing to the circumstance that it has given rise to a controversy which has engaged the active interest of some of the strongest and subtlest intellects of this century. Some of the disputants have been men like Brougham, Jeffrey, and Muirhead, skilled in the arts of advocacy and in the faculty of eliciting and weighing evidence, who have stated their conclusions with all the "pomp and circumstance" of a judicial finding; others are men like Arago, Dumas, Harcourt, Whewell, Peacock, Kopp, George Wilson, eminent in science and literature, who have defended their convictions with great power, ample knowledge, much argumentative force and occasional eloquence. At one time the contest was waged with no little fury and bitterness; it threatened, indeed, like the famous controversy on the proper form of a lightning conductor during Sir John Pringle's presidency of the Royal Society, or like the equally famous controversy on the discovery of the planet Neptune, to attain the dignity of a national question, far more acute, I should imagine, than that which has just occasioned all right feeling Scotchmen to approach the Queen in council on the subject of Scotland's proper place and designation in imperial concerns.

But the acrimony and ill-feeling have happily long since passed away. There is no longer any need to discuss the question either as an advocate or as a partisan. What I shall attempt to-night is to treat it dispassionately, and, within the compass of an hour, to assess, as impartially as I am able, Watt's true place in regard to this discovery.

It was, indeed, an epoch-making event. The discovery of the composition of water was as momentous for science as the greatest of Watt's inventions was for social and economic progress. The very fact itself, apart from all that flowed from it, was of transcendent interest. But to those who had eyes to see, its supreme importance was in its fruitful and far-reaching consequences. It signified nothing less than the passing away of an old order of things, the downfall of a system of philosophy which had outlived its usefulness, in that it no longer served to interpret natural phenomena, but which was rather a hindrance and a stumbling block to the perception of truth. The discovery at once led to the inception of a more rational and more truly comprehensive theory, which not only explained what was already known, in a fuller, clearer, and more intelligible manner, but pointed the way to new facts hitherto undreamt of, which, in their turn, served to strengthen and extend the generalization which led to their discovery. No wonder, then, that those who loved and revered Watt, and who were rightly jealous of his honor, should have sought to do all in their power to vindicate what they honestly conceived to be his just title to so signal and so fundamental a discovery.

No man has a juster claim to be regarded as a scientific man, in the truest and noblest sense of that term, than James Watt. The scientific spirit was manifest in him even in boyhood. The very circumstances of his condition, his weakly frame, the solitariness of his school life, and the early habits of introspection thus induced in a mind forced to feed only on itself, served to strengthen and develop the instinct. Even his early struggles, and the jealousy of the Glasgow guilds which forbade him to practice his trade in the burgh in which he had not served an apprenticeship, conduced to mould his character and to determine the bent of his mind. Hard and illiberal as it seemed at the time, the Zunftgeist which drove him to the shelter of the old college in the High Street, and secured for him the abiding friendship of Black and Robison, was in reality the most fortunate circumstance in his career. It brought him directly under the influence of one of the greatest natural philosophers of his age, and so stamped him permanently as a man of science.

It would not be difficult to trace how his influence reacted upon all that Watt subsequently did—from the time of his earliest speculations on the loss of energy in Newcomen's engine down to the very last of his mechanical pursuits in the dignified retirement of Heathfield Hall. He approached the question of the improvement of the steam engine as a scientific problem, and under the direct inspiration of the doctrine of the great discoverer of the principle of latent heat. It was this same mental attitude toward scientific truth, the same receptivity for scientific doctrine, the same love of pondering over and speculating upon the true inwardness of things, that brought him the friendship of Priestley, Withering, Wedgwood and De Luc, and that ultimately made him a cherished member of the foremost scientific academies of the world. It will occasion little surprise to one who has formed a true perception of his character to learn that Watt was wont, even at periods of great mental depression, and of physical suffering, amid all the toil and anxious worry of a business surrounded with difficulties, to find peace in the contemplation of natural phenomena, and to spend time in philosophical speculation.

The shrinking, diffident man, in thus communing with himself and with nature, followed a true and constant impulse to withdraw from the strife and turmoil of the world, and to seek his pleasure and his rest in the silent contemplation of natural truth. No one can look upon that contemplative face without being struck with its expression of philosophic calm. What deep, genuine pleasure these communings brought to the harassed man may be gleaned from his correspondence. In truth, nature intended Watt to be a philosopher of the pattern of Boyle, or Newton, or Dalton; it was destiny that drove him into the world of affairs, where, as he said, he was out of his sphere. It is necessary to dwell for a moment on this aspect of Watt, in order to form a just appreciation both of his position and of his merits in regard to the great chemical truth with which his name is associated.

The man of action is apt to regard the contemplative mind with something akin to contempt. I once heard a bustling, busy man, the head of a large engineering establishment, who had enjoyed the good fortune to be a pupil of Thomas Graham, say of that distinguished philosopher that he was the laziest man he had ever met. He did not say he "ever knew"—for how little he really knew of Graham was evident from the fact that at the period to which he referred Graham's thoughts were deeply occupied with some of the most memorable of his investigations.

It was in one of these contemplative moods—in what he himself styled his periods of excessive indolence—and as it happened at the very time that the Soho firm was struggling to protect itself against the unprincipled horde that was seeking to infringe Watt's fundamental patent, that he occupied himself with turning over in his mind the outcome of one of his friend Priestley's multitudinous experiments. Watt had long held the view that air was a modification of water, or, as he expressed it in a letter to his friend Black, under date December 13, 1782, that, "as steam parts with its latent heat as it acquires sensible heat, when it arrives at a certain point it will have no latent heat, and may, under proper compression, be an elastic fluid nearly as specifically heavy as water," at which point he conceived it would again change its state and become air. As he then relates, he sees a confirmation of this opinion in an experiment of Priestley's made, as he says, "in his usual way of groping about." "As he [Priestley] had succeeded in turning the acids into air by heat only, he wanted to try what water would become in like circumstances. He under-saturated some very caustic lime with an ounce of water, and subjected it to a white heat in an earthen retort. . . . No water or moisture came over, but a quantity of air, equal in weight to the water, . . . a very small part of which was fixed air, and the rest of the nature of atmospheric air. . . . He has repeated the experiment with the same result."

About a fortnight later Priestley wrote that he was able to convert water into air "without combining it with lime or anything else, with less than a boiling heat, in the greatest quantity, and with the least possible trouble or expense." He added that "the method will surprise more than the effect," but that he would defer "the communication of the hocus pocus of it" until such time as Watt should give him the pleasure of his company in return for the pleasure he was to give Watt in speculating on the subject.

These experiments, as we shall see in due course, were wholly fallacious; in following them up with his wonted ardor, Priestley quickly found himself in a maze of contradictions, and ultimately discovered that this seeming conversion was absolutely mythical.

It may be useful, however, to make one or two comments on these passages at the present juncture. In the first place, Watt's opinion as to the relation of water and air, although founded, as he thought, upon a more philosophical basis, simply embodied the teaching of the schoolmen. The notion that the so-called four elements were mutually convertible, or were in essence identical, ran through the doctrine of twenty centuries of teachers. Despite the onslaughts of the Spagyrists and the author of the "Sceptical Chymist," it permeated the literature of natural philosophy down to the very beginning of this epoch. Watt was insensibly swayed by a belief which had descended to him, like the undying germ, through the ages, and he could no more shake himself free of it than he could get rid of the influence of heredity. The very mode in which he, in common with men of his time, uses the term "air" is an indication of the manner in which the ancient creed limited and cramped his thought. He knew that there were various "airs," but it is very doubtful if he realized that they were essentially different substances. There is abundant evidence in the few chemical papers that he published, and especially in his letters to Black, Priestley, De Luc, Kirwan and others, that he regarded them all as constituted of the same matter, affected by attributes more or less fortuitous and accidental. Thus all the varieties of inflammable air were at bottom identical, with properties modified by their origin or their varying content of the hypothetical principle phlogiston—that is the principle that was assumed to make them burn.

From Watt's published correspondence we are able to judge how he regarded Priestley's further work on this so-called conversion of water into air. He admits that the facts are "in some degree contradictory to each other." The apparent conversion would seem to depend upon the material of the vessel in which it was made. In a glass vessel no air was produced, nor was any found in a gun barrel when the distillation was done slowly; but when confined by a cock, "and let out by puffs, it produces much air; which," says Watt, "agrees with my theory, and also coincides with what I have observed in steam engines. In some cases I have seen the tenth of the bulk of the water, of air extricated or made from it." Davy once said "the human mind is governed not by what it knows, but by what it believes; not by what it is capable of attaining, but by what it desires." However willing to catch at anything in support of his belief, it is possible that Watt might have been led to doubt the soundness of Priestley's experiment, if an apparent and wholly unlooked for confirmation of it had not arisen.

To make the account exact, and in view of what is to follow, it is necessary to go back a little, in point of time. In the spring of 1781, Priestley performed what he styled "a mere random experiment made to entertain a few philosophical friends." It was practically a repetition of Volta's experiment of firing a mixture of the inflammable air from metals, that is, hydrogen, with common air in a closed glass vessel by means of the electric spark. After the deflagration the vessel was found to be hot, and on cooling, its sides were observed to be bedewed. Neither Priestley nor any of his philosophical friends seemed to have paid particular attention to the deposit of moisture, or, at all events, if they did, they failed to perceive its significance. One of them, however, Mr. John Warltire, a lecturer in natural philosophy in Birmingham, imagined that the experiment might afford the means of showing whether heat was ponderable or not; and accordingly he repeated it, using for greater safety a copper globe, weighed before and after the passage of the spark. A minute loss of weight was always noticed, "but not constantly the same; upon the average it was about two grains."*

Priestley, who, with Withering, was present when the experiments were made, confirmed the apparent loss of weight; but he added, with a caution that was not characteristic, that he did not think "that so very bold an opinion as that of the latent heat of bodies contributing to their weight should be received without more experiments, and made upon a still larger scale."

Priestley's volume—the sixth in the series—was published in 1781, and was certainly known to Watt; indeed, in the appendix are printed a number of observations made by him apparently as the work was passing through the press. Although, therefore, he must have had his attention drawn about this time to the formation of the dew in Priestley and Warltire's experiment, there is nothing to show that he attached any importance to the circumstance, or that, if he did, he dissented from Warltire's conclusion that common air deposits its moisture when it is phlogisticated.

For some time previous to the publication of Priestley's book, Mr. Cavendish was engaged upon an inquiry "to find out the cause of the diminution which common air is well known to suffer by all the various ways in which it is phlogisticated, and to discover what becomes of the air thus lost or condensed." In other words, it was an investigation to determine the changes experienced by air when bodies were made to burn in confined portions of it. On the appearance of Priestley's book he repeated Warltire's experiment, thinking "it worth while to examine more closely, as it seemed likely to throw great light on the subject I had in view." He confirmed the observation on the formation of dew; but although he made the experiment on a larger scale, and with varying proportions of the two airs, he was unable to satisfy himself as to the loss of weight after the explosion. As the result of a number of trials, made both with the inflammable air from zinc and from iron—that is, hydrogen—and mixed with common air in the proportion of 423 measures of the inflammable air to 1,000 of common air, he says, "we may safely conclude, that when they are mixed in this proportion, and exploded, almost all the inflammable air and about one-fifth part of the common air lose their elasticity, and are condensed into the dew which lines the glass." In order to examine the nature of this dew, large quantities of the hydrogen were burnt with two and a half times its volume of common air, and the product of the combustion was caused to pass through a long glass tube whereby it was condensed. "By this means 135 grains of water were condensed in the cylinder [i. e., the tube], which had no taste nor smell, and which left no sensible sediment when evaporated to dryness; neither did it leave any pungent smell during the evaporation; in short, it seemed pure water. . . . By the experiments with the globe, it appeared that when the inflammable and common air are exploded in a proper proportion, almost all the inflammable air, and nearly one-fifth of the common air, lose their elasticity, and are condensed into dew. And by this experiment it appears that this dew is plain water, and consequently that almost all the inflammable air and about one-fifth of the common air are turned into pure water."

The idea that common air was for the most part a mixture of two gases—oxygen or the dephlogisticated air of Scheele and Priestley, and nitrogen or the mephitic air of Rutherford, the azote of Lavoisier—was familiar to chemists at this period as the result of the teaching of Scheele and Lavoisier, and there is reason to suppose that this opinion was shared by Cavendish.

He had been engaged for some time past in an elaborate inquiry into the constitution of atmospheric air, the results of which admitted of no other interpretation than that common air was composed of two different gases, mixed or combined in constant relative proportions. It is true that in the memoir containing the results of his inquiry he nowhere directly gives his estimate of these relative quantities, but from the data he affords, it is easy to deduce the amount and the constancy of the proportion. Cavendish's papers are characterized by remarkable conciseness and brevity; an experiment which must have involved the putting together of elaborate and complicated apparatus, and which must have occupied considerable time in its performance, is described in a few lines, and hence it is not always possible to gather with certainty the precise disposition of the arrangements. He never sets out his reasons or his conclusions with any great

*The Watt Memorial Lecture, delivered in the Watt Memorial Hall, Greenock, on March 11, by Prof. T. E. Thorpe, LL.D., F.R.S.—From Nature.

* The account of these experiments is given in a letter to Priestley, and constitutes No. v of the "Appendix to Priestley's Experiments and Observations relating to various branches of Natural Philosophy, etc.," vol. ii. (Birmingham, 1781).

amount of detail, and his published words occasionally give little indication of his line of thought. But that he clearly recognized that only one portion of common air was concerned in the formation of water, and that this portion was the dephlogisticated air, or oxygen, is obvious from the next series of experiments in which he fired a mixture of about two measures of hydrogen and one measure of oxygen in a previously exhausted glass globe furnished with an apparatus for firing air by electricity.

When the included air was fired, almost all of it lost its elasticity, so that fresh quantities of the explosive mixture could be introduced and the process repeated until a sufficient quantity of the moisture was obtained for examination. In these experiments Cavendish clearly and definitely demonstrated that the weight of the water was practically equal to the weight of the mixed gases which had combined to form it. In some cases the water was perfectly neutral in its reaction: in others it was slightly acid, and the cause of this acidity caused Cavendish much experimenting, but he is never in any doubt as to the main result; he says distinctly, "if those airs could be obtained perfectly pure, the whole would be condensed." Now if Cavendish had published this main result at the time he obtained it, namely, in the summer of 1781, or even if he had formally communicated it to one of the meetings of the Royal Society during the ensuing session, there would have been no Water Controversy. But even if he were ready, it was characteristic of him to delay, not from inertia or indolence, but from a morbid shyness, an unconquerable reticence, which constantly led him to postpone any public announcement of his work. He had the additional, and to him all-sufficient, reason that he had not yet worked out the cause of the occasional acidity of the water. What he did, however, was to communicate the facts of his experiments to Priestley, as Priestley himself states in a subsequent paper published in the Philosophical Transactions for 1783. When or how he communicated them to Priestley does not appear, nor have we any means of knowing precisely what was said.

Something, however, on this point may be inferred from what Priestley proceeded to do. It appears from a letter to Wedgwood that he repeated Cavendish's experiment during the March of 1783. It will be remembered that he was at this period engaged on his experiments on the seeming conversion of water into air. He had obtained a number of contradictory results which had led Wedgwood, as far back as the previous January, to put certain sagacious queries, which doubtless in the end had their effect in opening Priestley's eyes to the origin of his mistake. But at the time both he and Watt were seeking for fresh evidence to substantiate the possibility of this conversion. Now just as Cavendish thought that Warltire's experiment might throw light upon the particular matter on which he was engaged, so Priestley considered that Cavendish's work might afford evidence, indirect it is true, but still evidence, of the intimate connection between water and air. Cavendish had, he thought, established the converse of the proposition which he and Watt were seeking to prove in showing that "air," or rather certain kinds of "air," could be converted into water weight for weight. It was no longer the original Warltire experiment of exploding common air and hydrogen. Cavendish had indicated the particular kinds which were really concerned in the phenomena, and it was the Cavendish experiment, pure and simple, which he proceeded to repeat. This is obvious from what he says: "Still hearing of many objections to the conversion of water into air, I now gave particular attention to an experiment of Mr. Cavendish's concerning the *reconversion* of air into water by *decomposing* it in conjunction with inflammable air." Priestley here used the word "decomposing" in a sense contrary to that which the context implies; but that he is consistent in so using it is evident from what follows, and also from similar expressions to be found in his correspondence. But although he professed to repeat Cavendish's experiment, he neglected to do so in Cavendish's manner. He says: "In order to be sure that the water I might *find in the air was really a constituent part of it*, and not what it might have imbibed after its formation [i. e., by contact with the water of the pneumatic trough], I made a quantity of both dephlogisticated and inflammable air, in such a manner as that neither of them should ever come into contact with water, receiving them as they were produced in mercury; the former from niter, and in the middle of the process (long after the water of crystallization was come over), and the latter from perfectly made charcoal. The two kinds of air thus produced I decomposed by firing them together by the electric explosion, and found a manifest deposition of water, and to appearance in the same quantity as if both the kinds of air had been previously confined by water.

"In order to judge more accurately of the quantity of water so deposited, and to compare it with the weight of the air decomposed, I carefully weighed a piece of filtering paper, and then, having wiped with it all the inside of the glass vessel in which the air had been decomposed, weighed it again, and I always found, as nearly as I could judge, the weight of the decomposed air in the moisture acquired by the paper. . . . . I wished, however, to have had a nicer balance for the purpose; the result was such as to afford a strong presumption that the air was reconverted into water, *and, therefore, that the origin of it had been water.*"

These passages, when compared with the accounts given of his own work by Cavendish, strikingly exemplify the difference in the character of the two experimentalists. It would be difficult to pack a greater number of errors into a couple of paragraphs than are contained in these sentences. The expressions in italics show that Priestley wholly failed to comprehend the true origin of the water. In his laudable anxiety to free the two gases from extraneous moisture, he committed blunder after blunder. His method of obtaining the oxygen was bad; that of procuring the inflammable air was worse. Both the gases must have been highly impure, and it was a physical impossibility that they should have given their aggregate weight in water, even after making every allowance for Priestley's crude and imperfect method of determining it.

Bad, however, as the experimental work was, what it appeared to teach was not lost on Watt; it clearly proved to him that water and air were mutually convertible. How the theory took shape in his mind is evident from the terms in which the two series of Priestley's experiments are coupled together in his letters to Gilbert Hamilton, to De Luc, and to Black. Each set is regarded as complementary to the other, and, both taken together, are held to prove that air and water are mutually convertible, and are therefore essentially the same. Under date April 21, 1783, he tells Black that "Dr. Priestley has made more experiments on the conversion of water into air, and I believe I have found out the cause of it; which I have put in the form of a letter to him, which will be read at the Royal Society with his paper on the subject." He then proceeds to give Black a summary of the three sets of facts, or supposed facts, on which he bases his generalization, and he makes use of these significant words: "In the deflagration of the inflammable and dephlogisticated airs, the airs unite with violence—become red hot—and on cooling, totally disappear. The only fixed matter which remains is water; and water, light, and heat are all the products. Are we not, then, authorized to conclude that water is composed of dephlogisticated and inflammable air, or phlogiston, deprived of part of their latent heat, and that dephlogisticated, or pure air, is composed of air deprived of its phlogiston, and united to heat and light? and if light be only a modification of heat or a component part of phlogiston, then pure air consists of water deprived of its phlogiston and its latent heat." Very similar turns of expression and trains of reasoning are to be met with in other letters to his friends, written at about the same period. In all it is abundantly clear that, whatever may have been his surmises as to the real nature of water, it was the conception of the mutual convertibility of air and water that was uppermost in his mind. These passages, however, constitute Watt's claim to be regarded as the true and first discoverer of the compound nature of water.

Three days after the letter to the Royal Society was written, or rather dated, there came a bolt from the blue in the form of a letter from Priestley to Watt. "Behold," it said, "with surprise and with indignation the figure of an apparatus that has utterly ruined your beautiful hypothesis, and has rendered some weeks of my labor in working, thinking, and writing almost useless." The doubts of Wedgwood, certainly no mean authority on the properties of baked clay, had, in fact, led Priestley to devise an experiment by which it was proved beyond all doubt that this seeming conversion of water into air was really due to an interchange of steam and air, effected by diffusion through the porous material of the retort. Well might Priestley cry to De Luc, "We are undone!" Watt's faith in the "beautiful hypothesis" was no doubt rudely shaken, but it was not shattered. In his answer to Priestley he denied that it was ruined: "It is not founded," said he, "on so brittle a basis as an earthen retort." Priestley, however, would have none of it; theories with him—always excepting the all-comprehensive one of phlogiston, which was the head and front of his creed, as, indeed, of his subsequent offending—had at no time much value, for as Marat said of Lavoisier, he abandoned them as readily as he adopted them, changing his systems as he did his shoes. Indeed, he rather prided himself on his capacity for quick change. "We are, at all ages," he once said, "but too much in haste to understand, as we think, the appearances that present themselves to us. If we could content ourselves with the bare knowledge of new facts, and suspend our judgment with respect to their causes, till by their analogy we were led to the discovery of more facts, of a similar nature, we should be in a much surer way to the attainment of real knowledge." With a candor all his own, he immediately added: "I do not pretend to be perfectly innocent in this respect myself; but I think I have as little to reproach myself with on this head as most of my brethren; and whenever I have drawn general conclusions too soon, I have been very ready to abandon them. . . . I have also repeatedly cautioned my readers, and I cannot too much inculcate the caution, that they are to consider new facts only as discoveries, and mere deductions from these facts as of no kind of authority; but to draw all conclusions, and form all hypotheses, for themselves."

Watt's mind was of a very different cast. He did not lightly adopt opinions; his convictions were slowly and deliberately formed, and were retained with a corresponding tenacity. But, all the same, he eventually thought it prudent to withdraw his letter; and three days prior to the reading of Priestley's paper, which accompanied it, Priestley informed Sir Joseph Banks of Watt's desire that the letter should not be publicly read. That it was withdrawn on account of what Watt calls Priestley's "ugly experiment," is stated by him in a letter to Black, on the ground that this experiment rendered "the theory useless in so far as relates to the change of water into air. . . . I have not given up my theory [that is, as to the mutual convertibility of water into air], though neither it nor any other known one will account for this experiment."

In the meantime Cavendish had been pursuing his inquiries, and toward the end of this year (1783) he was prepared to give the explanation of the cause of the disturbing factor in his proof of the real nature of water—that is, the origin of the occasional and apparently haphazard presence of small quantities of nitric acid. This he demonstrated to be due to the difficulty of excluding a greater or less quantity of atmospheric nitrogen from the gases employed; and he determined the conditions under which this nitrogen led to the formation of the acid, the true nature of which he thus for the first time established. The account of his labors was read to the Royal Society on January 15, 1784.

In the previous autumn, however, disquieting rumors reached this country that the French philosophers, and chief among them Lavoisier, were poaching upon the English preserves. The circumstance is alluded to in a letter from Watt to De Luc, dated November 30, 1783. "I was at Dr. Priestley's last night. He thinks, as I do, that Mr. Lavoisier, having heard some imperfect account of the paper I wrote in the spring, has run away with the idea and made up a memoir hastily, without any satisfactory proofs. . . . I, therefore, put the query to you of the propriety of sending my letter to pass through their hands to be printed; for even if this theory is Mr. Lavoisier's own, I am vain enough to think that he may get some hints from my letter, which may enable him to make experiments, and to improve his theory, and produce a memoir to the academy before my letter can be printed, which may be so much superior as to eclipse my poor performance and sink it into utter oblivion; nay, worse, I may be condemned as a plagiary, for I certainly cannot be heard in opposition to an academician and a financier. . . . . But, after all, I may be doing Mr. Lavoisier injustice."

That Lavoisier did get some hints, and possibly even through the medium of Watt's letter, is beyond all question. The fact that he was informed of Cavendish's work is specifically stated in Cavendish's memoir in a passage interpolated by Blagden, the secretary of the Royal Society and Cavendish's assistant and amanuensis, who himself told Lavoisier. The whole of the circumstances are set out in detail in a subsequent letter which Blagden addressed to the editor of the Chemische Annalen in 1786. That it was known to be Cavendish's experiment that was being thus repeated is confirmed by a letter from La Place to De Luc, dated June 28, 1783, in which we read: "Nous avons répété, ces jours derniers Mr. Lavoisier et moi, devant Mr. Blagden, et plusieurs autres personnes, l'expérience de Mr. Cavendish sur la conversion en eau des airs dephlogistiqués et inflammables, par leur combustion. . . . Nous avons obtenu de cette manière plus de 2½ gros d'eau pure, ou au monis qui n'avoit aucun caractère d'acidité, et qui étoit insipide au goût; mais nous ne savons pas encore si cette quantité d'eau représente le poids des airs consumes; c'est une expérience à recommencer avec toutes l'attention possible et qui me paroit de la plus grande importance." The phrase "qui n'avoit aucun caractère d'acidité" is of special significance. The French philosophers, and Lavoisier in particular, could with difficulty, as Blagden relates, be brought to credit the statement that when inflammable air was burnt, water only was formed; their preconceptions concerning the part played by oxygen in such a case led them to suppose that an acid would be produced. Cavendish was familiar with Lavoisier's doctrine, which is connoted in the very word oxygen, which we owe to the French chemists; and it may be that this circumstance was, among others, one cause of the pains he took to understand the origin of the acid he occasionally met with. Lavoisier was led to repeat Cavendish's experiment on June 24, 1783; and on the following day he announced to the Academy that by the combustion of inflammable air with oxygen "very pure water" was formed. It is this statement that has been said to constitute Lavoisier's claim to be considered as the true and first discoverer of the composition of water. That he has no valid claim has been implicitly admitted by Lavoisier himself. The eminent Perpetual Secretary of the French Academy, M. Berthelot, is no doubt accurate in regarding June 25, 1783, as the first certain date of publication of the discovery that can be established by authentic, i. e., official, documents; but as I have elsewhere attempted to show, the circumstances under which that priority of publication was secured give Lavoisier no moral right to the title of the discoverer.*

Shortly after the reading of Cavendish's memoir to the Royal Society (January 15, 1784), De Luc wrote to Watt, giving an account of its contents, and insinuating that its conclusions had been formed in the light of knowledge obtained from Watt's letter to the Royal Society, which although, as we have seen, not publicly read, had, there is no doubt, been perused by others than Priestley, to whom it was originally addressed. De Luc was no doubt a zealous friend, but in this letter his zeal outran his discretion. The letter was, indeed, unworthy of him. He hastens to exculpate Lavoisier and La Place, but makes a charge against the honor and integrity of Cavendish, for which there was absolutely no justification. He stirs up Watt's suspicions, and then seeks to appease them; he rouses his anger, and then counsels him to silence by an argument which shows how wholly he misunderstood Watt.

Watt's reply was characteristic: "On the slight glance I have been able to give your extract of the paper, I think his theory very different from mine; which of the two is the right I cannot say; his is more likely to be so, as he has made many more experiments, and consequently has more facts to argue upon. . . .

"As to what you say of making myself des jaloux, that idea would weigh little; for were I convinced I had had foul play, if I did not assert my right, it would either be from a contempt of the modicum of reputation which could result from such a theory; from a conviction in my own mind that I was their superior, or from an indolence that makes it easier for me to bear wrongs than to seek redress. In point of interest, in so far as connected with money, that would be no bar; for though I am dependent on the favor of the public, I am not on Mr. C. and his friends, and could despise the united power of the illustrious house of Cavendish, as Mr. Fox calls them.

"You may, perhaps, be surprised to find so much pride in my character. It does not seem very compatible with the diffidence that attends my conduct in general. I am diffident, because I am seldom certain that I am in the right, and because I pay respect to the opinion of others, where I think they may merit it. At present je me seus un peu blessé; it seems hard that in the first attempt I have made to lay anything before the public I should be thus anticipated."

There was no desire on the part of anybody connected with the management of the Royal Society to withhold from Watt his just due; and it was eventually arranged that his letter to Priestley, together with one he subsequently addressed to De Luc, should be publicly read to the fellows, and they were subsequently ordered to be printed in The Philosophical Transactions in such manner as their author might desire. By his directions the two letters were merged together, and they appear as having been read on April 29, 1784, under the title, "Thoughts on the constituent parts of water and of Dephlogisticated air: with an account of some experiments on that subject. In a letter from Mr. James Watt, engineer, to Mr. De Luc, F.R.S." The greater part of the "thoughts" are concerned with the dephlogisticated air. What relate to water have already been given in the extracts from his correspondence. The terms in the letter to De Luc, as printed in the Philosophical Transactions, are substantially identical with those of the letters to Black, Hamilton, Smeaton, and Fry.

I have now given all the essential facts which led to

* Priestley, Cavendish, Lavoisier, and "La Revolution Chimique;" the Presidential Address to the Chemical Section of the British Association, 1890; see also "Essays in Historical Chemistry" (Macmillan, 1894).

the recognition of the true chemical nature of water, and I have stated, as accurately and as impartially as I could, the relative share of Watt, Cavendish, and Lavoisier in their discovery and interpretation. As regards Lavoisier, it cannot be claimed that he was the first to obtain the facts. To Cavendish belongs the merit of having supplied the true experimental basis upon which accurate knowledge could alone be founded. Watt, on the other hand, although reasoning from imperfect and, indeed, altogether erroneous data, was the first, so far as we can prove from documentary evidence, to state distinctly that water is not an element, but is composed, weight for weight, of two other substances, one of which he regarded as phlogiston and the other as dephlogisticated air. It would be a mistake, however, to suppose that Watt taught precisely the same doctrine of the true nature of water that we hold to-day. Nor did Cavendish utter a more certain sound. What we regard to-day as the expression of the truth we owe to Lavoisier, who stated it with a directness and a precision that ultimately swept all doubt and hesitation aside—except to the mind of Priestley, whose "random experiment" gave the first glimmer of the truth.

In this respect the conclusion of Lord Brougham is most just. It was a reluctance to give up the doctrine of phlogiston, a kind of timidity on the score of that long established and deeply rooted opinion, that prevented Watt and Cavendish from doing full justice to their own theory; while Lavoisier, who had entirely shaken off these trammels, first presented the new doctrine in its entire perfection and consistency.

We thus see that each of these eminent men played an independent and, we may say, an equally important share in the establishment of one of the greatest scientific truths that the eighteenth century brought to light.

As regards Watt, the history of this incident serves to bring out only more clearly what we know to be the true character of the man. It illustrates the vigor of his intellectual grasp, the keenness of his mental vision. At the same time it exhibits his love of truth for truth's sake; his unaffected modesty and the sense of humility that was not the less real because accompanied by a sense of what his inherent love of rectitude taught was due also to himself. The voice of envy and detraction has not been unheard among the strife of partisans in the water controversy, but throughout it no syllable has been breathed that reflected even remotely upon his honor and integrity.

THE WINE OF FRANCE.

The wine product of France in 1875 has never since been equaled, says Bradstreet's. In that year the yield of the twenty leading departments amounted to 873,014,000 gallons, twenty years later the production was only 325,000,000, and the year 1897, just closed, the yield was 629,709,070 gallons, about 29,000,000 gallons larger than in 1896, but 144,000,000 gallons smaller than in 1875, the year of maximum production before the phylloxera attacked the vines. The value of last year's vintage is estimated at $132,000,000, about $10,500,000 of which is what are called high brands, the balance being common wine, drunk by the people and bought in the vineyards or their immediate vicinity. The twenty departments for which statistics are available produce, roughly speaking, about six-sevenths of all the wine of France, because the total yield of the entire country in 1897 is placed at 727,791,000 gallons, of which the twenty departments mentioned produced 630,000,000 gallons. The foregoing facts are contained in the report of Consul Covert, of Lyons, to the Bureau of Foreign Commerce of the State Department.

Aside from the natural source of wine production, there are other directions in which wine, so called, is produced. The production of wine from alcohol in 1897 is placed at 37,084,000 gallons, while that made from dried grapes is estimated at 23,458,000 gallons. The alcohol product so called is formed by treating the residue of the grape, after the wine has been extracted, with sugar and water. Alcohol is thus generated and a variety of wine called "piquette" is made. The wine from raisins is manufactured from dried fruit imported from Algeria, Tunis, Corinth, and Spain, the aggregate importations of which in 1897 were 42,000,000 pounds. Of the total quantity of wine produced in France, nearly one-third comes from the department of the Hérault, and this, with four others, produces five-eighths of the entire French wine crop. Notable decreases in the yield throughout the Burgundy vineyards, the Charente and some of the smaller departments were shown in 1897 as compared with 1896. The most flourishing vineyards seem to be in the district in which Consul Covert is stationed—the valley of the Rhone. A much larger quantity of wine is imported into France than is shipped therefrom. In the calendar year 1896 the total imports were 198,000,000 gallons, while the exports were only 40,000,000 gallons, or only about one-fifth of the imports. The area in grapes in 1897 was the smallest for more than ten years past, amounting to only 4,222,000 acres. More than half of the wine imported comes from Spain, next in order being Algeria and Tunis. That France, in spite of the phylloxera, retains the premier position in the wine production of Europe, is evident from the following figures of production of wine in 1897, by countries, in Europe:

Country.	Production in 1897. Gallons.
France	727,791,245
Italy	485,390,000
Spain	447,750,000
Roumania	72,500,000
Austria-Hungary	62,500,000
Russia	56,250,000
Portugal	56,250,000
Germany	47,250,000
Turkey	40,500,000
Switzerland	28,125,000
Greece	27,000,000
Bulgaria	24,525,000
Servia	20,250,000

Consul Covert notes the fact that successful efforts at grafting American varieties on the French vines have been made, and hundreds of vineyards are now producing grapes from this source. Some of the wine has been mixed with the product of the French vines with satisfactory results, and considerable is produced direct from the American vines and bears that name. The influence of the soil and climate is said to have caused the product of the transplanted vine to compare favorably with the native, and it is calculated that the imported variety, after a naturalization of ten years, will, with the aid of grafting, yield a quality of wine equal to the best in that locality. The costliest wines, however, still continue to come from vines that date back from a century to a century and a half ago.

THE MANUFACTURE OF PERFUMES AT GRASSE.

The extraction of perfumes is an exceedingly complex art. The frailty of flowers, the faintness of their aroma, the quantities that must be treated, and the rapidity with which they bloom, easily explain the difficulties of the problem. Then, too, other considerations intervene. The flowering of the same plant differs according to the time of the day; hot air and light momentarily increase the production of odors, or completely suppress it if their effect is prolonged. Flowers gathered in the heat of the sun yield less odor than when cut at daybreak, and their fragrance becomes more delicate in elevated, humid soil than on dry lowlands exposed to heat. To the question of delicate treatment adapted to the character of each aromatic substance are therefore added complications of odoriferous maturity, and of gathering at propitious moments, that necessitate a somewhat lengthy experience on the part of the manufacturer of perfumes.

The department of the Maritime Alps is a marvelous garden that has always given French perfumery an indisputable supremacy, and is, moreover, the granary of foreign perfumeries. The pretty city of Grasse, the sole center of flowers of the entire world, has, for several centuries, been the home of an extensive, interesting, and very picturesque industry. The cutters, women and children, at daybreak, before the rays of the sun have fallen upon the flowers (and sometimes called by the sound of a horn at night when a storm threatens), assemble, and, excited by the rhythm of their songs, perch upon the trees or stoop beneath the bushes to do the gathering (Fig. 1). For the most part these are Italians, since the ordinary native force does not suffice. As happens with all harvests, there are here mercenaries. The cut flowers are put into bags and carried upon the backs of donkeys to the works, where they are received by girls who sort them (Fig. 2), and spread them out upon the pavement of a cool hall, where the manipulator comes to get them. Before entering into details regarding the different operatory methods, it will be well to explain how the perfume originates, where it resides, and under what conditions it is disengaged. The essential oil is localized in the cells of the upper surface of the petals and sepals, in superficial parts, the prominent glands, and the shallow reservoirs of such organs. It is therein associated with fixed oils, resin, gum, and tannin.

Each cell is not only a reservoir of essential oil, but is itself a manufactory thereof. The perfume is not the result of a splitting up, but is due to an act of vitality. Sometimes the essential oil accumulates in drops in the epidermis and sometimes it is eliminated, in measure as it is produced, in the form of odoriferous effluvia. There are, therefore, two sorts of flowers—those in which the perfume exists entirely condensed before beginning to evaporate and those in which it is gradually produced a few moments only before it is disengaged. Such difference is easily observed. If one rubs the petal of a rose, there will remain upon his fingers a very distinct odor of the flower; but if he rubs a jasmine, he will have merely the disagreeable scent of decaying verdure. Hence arise two different methods. The flowers that readily give up their concrete odor by rapid and violent means are treated by distillation, while the others require a slower and more delicate process—the use of a solvent.

Fig. 1.—GATHERING FLOWERS AT GRASSE.

Here is presented a second difficulty, that of separating the essential oil from resin, tannin, and impurities. A solvent of the essential oil will, as a general thing, carry along a portion of these substances. If, for example, the oil is soluble in the aqueous liquids that impregnate the tissues of the flower, it will partake of the ill odor thereof. On the other hand, if it is too active, it will kill the plant and prevent the odor from developing. A perfect separator would therefore be neutral, indifferent, and odorless, and of such a character as to attach itself to the essential oil alone. Such an ideal remains to be found. We have to be content with a solvent of medium qualities that has for a long time given nearly satisfactory results.

This is a mixture of beef suet and lard washed, melted, and prepared with the greatest care. It may be replaced by very pure olive oil or highly refined neutraline oil.

Such are the two principal methods—distillation and solution. The latter, when performed in the warm way, is called maceration, and, in the cold, enfleurage.

Fig. 2.—SORTING FLOWERS AT THE BRUNO-COURT ESTABLISHMENT.

There are but two flowers that will withstand distillation—the rose and the orange flower. Twenty-five gallons of water and 110 pounds of flowers are placed in a still, and heat is applied. The boiling water disorganizes the cells that imprison the essential oil, and sets the latter at liberty, the vapor condenses in a cool worm, and the water and essential oil are collected in a Florence flask, wherein the difference in density separates them. The stills are double bottomed and heated by a naked fire or by steam. The water of refrigeration is furnished by the streams that descend the neighboring mountains, run through the city of Grasse (which is built like an amphitheater), and pass successively from one establishment to another, and finally flow to the plains and supply the oil mills.

The manufacturers are admirably served by nature, which has been pleased to favor this fine flower industry, in which everything—crop, driers, and stills (sometimes established in old cellars)—assumes an artistic and picturesque aspect.

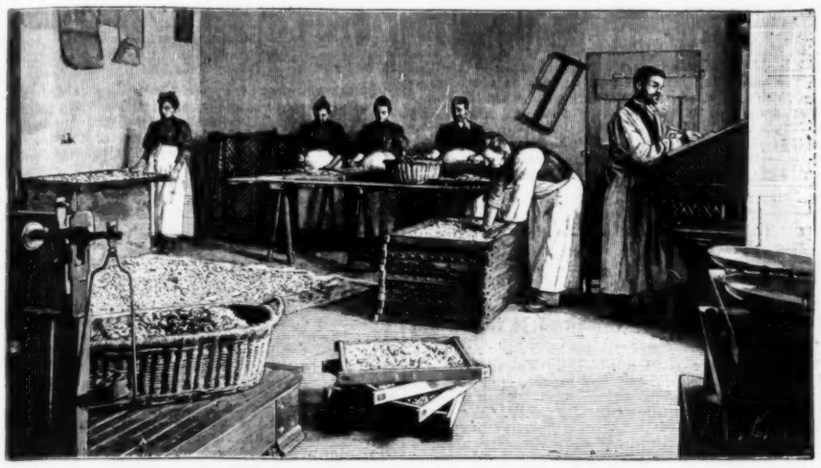


FIG. 3.—EXTRACTING PERFUMES BY THE ENFLEURAGE PROCESS.

Maceration is applied to the violet, cassia, jonquil, rose, and orange flower.

Women standing in front of a water bath stove melt the fat in tinned basins called "bugadiers." Into these they throw the flowers, and keep them submerged, by means of a spatula, at a temperature of about 65° for half an hour. Then they take them out, drain them, and pass the amalgamated residua, heated by boiling water, into a hydraulic press, in order to remove the last traces of fatty matter. But a single maceration does not suffice to perfume the suet, which is so far scarcely odoriferous. The workmen then take this same fat, recharge it with flowers and rebegin the operation, and proceed until the fatty body has acquired the desired strength. It is estimated that it takes five pounds of flowers to perfume a pound of fat.

With certain flowers, twenty-five treatments are required.

Enfleurage is employed for the jasmine and tuberose (Fig. 3). In the beginning it was performed in double plates called "tiames," and capable of holding twelve ounces of pomade! From the beginning of the present century, wooden frames 3 inches in depth, 24 inches in width, and 38 inches in length, and with a glass bottom, have been used.

A layer of fat is spread upon this glass by means of a spatula, and upon this are directly laid the flowers. The frames are arranged in piles of forty, one upon another. The flowers are thus inclosed between two frames, which form a small, close, cool chamber, in which the aroma develops under the best conditions possible. The next day the flowers are replaced by fresh ones, and so on until the pomade has acquired a sufficient strength of perfume. In order to manufacture perfumed oils, use is made of frames in which the glass is replaced by wire gauze upon which rests a piece of woolen saturated with oil. The perfumed oil is collected by pressing all the pieces of woolen.

The process is very lengthy, and with the jasmine takes three months. Moreover, it is very expensive, on account of the material that it requires. The smallest establishments possess 4,000 frames, and large works 40,000. One frame, in fact, cannot support more than 15 ounces of fat, and one piece of woolen more than 2 pounds of oil.

It now remains to convert the fatty matter perfumed by maceration into extracts.

To this effect, it is placed in contact with alcohol in receptacles, to which a strong alternating motion is given, and the agitation is continued until the alcohol has taken up the perfume. The alcohol is then separated by decantation.

Such are the main features of this manufacture, which, in order to solve numerous practical difficulties, requires a thousand precautions that it would take too long to enumerate. Fig. 4 shows the process of distillation.

In conclusion, we shall confine ourselves to giving a few interesting statistics.

In the department of the Maritime Alps there are annually treated:

4,400,000	pounds of	roses
5,500,000	"	" orange flowers
440,000	"	" jasmines
330,000	"	" cassia flowers
330,000	"	" tuberoses
440,000	"	" violets

FIG. 4.—DISTILLATION OF ESSENTIAL OILS AT THE PIVER ESTABLISHMENT.

The mean selling price of flowers per pound is as follows: violet and cassia, 40 cents; tuberose, 30 cents; jasmine, 25 cents; rose, 7 cents; and orange flower, 9 cents.

A violet plant is capable of furnishing 5 ounces of flowers, and an orange tree 2¼ ounces. A cutter, in the morning, say at 4 o'clock, is capable of gathering 44 pounds of roses, 6½ of jasmines, and 13 of tuberoses, and in an entire day 22 pounds of violets or orange flowers.

In order to produce a pound of neroli, it requires more than 500 pounds of orange flowers, say, approximately, 1,200,000 flowers; and for one pound of essential oil of rose, 8,000 pounds of roses, or 5,000,000 flowers.

More than 1,000,000 pounds of pomades or perfumed oils and 1,000,000 gallons of aromatic waters are annually manufactured. The production of perfumery in crude material, in the department of the Maritime Alps, is estimated at more than $3,000,000. For the above particulars and the illustrations we are indebted to La Nature.

MODERN VIEWS REGARDING CONSUMPTION.

THE keynote of the modern treatment of this malady hinges on the idea it is, to a large extent, the outcome of surroundings, and that unless these are altered it will proceed to fatality. Thus it is that so much stress is laid upon climate and change of climate. One may, indeed, fairly suppose that a good deal of the greater hopefulness in regard to the prognosis of the disease which is so striking a feature in the writings of physicians on the subject in these latter days is due to the increased facilities which now exist for obtaining change without that exhaustion and that risk which travel used to involve in former times. Thus do the hotel keepers flourish. There are difficulties, however, about hotels. On the one hand, ordinary travelers are becoming afraid of mixing with consumptives, and on the other, the consumptives are being taught that the good of travel lies in the fresh air, which they very obviously do not get in the hotels. Life in a special sanatorium for consumptives may not be altogether a joy, but it seems probable that the more thoroughly people come to appreciate the exact nature of their complaint, the more they will drift into special institutions in which all the arrangements are specially adapted to its treatment.

In the establishment of such sanatoria is seen prospect of some hope for those less fortunate ones to whom money is an object of much moment, for, considering the bare essentials, a sanatorium for consumptives ought not to be an inordinately expensive establishment. Fresh air is cheap; cleanliness need not be expensive when walls and floors are bare; and in any case man must eat, whether he be in a sanatorium or not. One can, indeed, hardly doubt that if once the sanatorium system were fairly introduced, and if establishments were set up on several scales to suit different purses, it would at last be possible to obtain proper treatment for the early stages of consumption, which at present is not the case. Notwithstanding the enormous prevalence of phthisis, one need have no hesitation in saying that practically none but the wealthy are able to obtain proper treatment in its early stages. A small, select number, after much waiting for their turn, can be received at a few places, where they will be well dealt with; but for the great mass no provision is made until they get "ill"—and the consumptive in the early and curable stage of his complaint is not what the average man would call "ill." What, then, about medicine? Is medicine to do nothing? Sir Samuel Wilks says: "The only remedies I know for consumption are air and sunshine—air, air, fresh air;" and the recent special tuberculosis number of The Practitioner, a volume of 155 pages, containing the latest views of many leading authorities, gives but nine pages to the medicinal treatment of the disease.

Of the many methods which have been put forward for the drug treatment of consumption, the free use of creosote or of guaiacol, the saturating of the patient with these or equivalent drugs, seems at the present moment to be the course which is supported by the most trustworthy evidence. It must be admitted, however, that, notwithstanding the number of drugs which have been vaunted as having a germicidal power over the bacilli of tuberculosis, so far no specific remedy has been found for the malady. A good deal, however, can be done, even while a patient is living in his own home and carrying on his own work, to increase his resisting power, so as to put him in the best condition to withstand the inroads of the disease. This, which may be called the management of phthisis, as apart from its cure, is a large subject, and the drugs which are useful are many; but a careful perusal of the pile of tuberculosis literature only serves to strengthen and drive home the conviction, on the one hand, that the death rate therefrom can be lowered far more effectually by efforts at prevention than by treatment of whatever sort; and on the other that, where prevention fails, the best hope lies, as Sir Samuel Wilks expresses it, in "air and sunshine—air, air, fresh air," whether these be got in high mountains, amid snow and ice, or on the sun-baked desert, whether on the veld or on the sea, or even in our own land in special institutions.—The Hospital.

A SANITARY BARBER SHOP.

ACCORDING to Berger (Centralbl. für Bakteriol., March 10, 1898) the conditions existing in barber shops are responsible for the spread of many diseases, not merely of the skin, hair, and beard, but infectious maladies as well. He suggests the following rules for practical guidance of barbers and legislators, since he considers that a barber shop is properly subject to public control. The barber himself should be free from epilepsy, spasms of any kind, drunkenness, and infectious diseases. Persons afflicted with contagious diseases of the skin, hair, beard, or genitals should not be allowed in a public shop, but should be attended to at their homes, where they should have all their own instruments. In the shop all brushes and combs should be made of good material, so that they may withstand frequent disinfection. Puff-balls should be replaced by balls of absorbent cotton, which should be thrown away after they have been once used. Towels, etc., should be freshly laundered for each person, unless paper napkins are employed and used only once. Combs should be cleaned and disinfected with corrosive-sublimate solution after each use. Shears, razors, and clippers should be boiled or wiped thoroughly with alcohol after each use. A barber should never wipe the razor upon his hand. Brushes to dust away the cut hair from the neck should be forbidden. A barber should pay special attention to the cleanliness of his own hands and person, and should be instructed in the appearances of diseases of the skin, scalp, and beard.

The Austrian government proposes to spend $20,000,000 to $25,000,000 for additions to the navy.—Oesterreichische Monatschrift für den öffentlichen Baudienst.

ENGINEERING NOTES.

One hundred miles of the railroad to Uganda are now open to traffic. The first-class fare for that distance is 38 rupees (about $8), second class 19 rupees, and third-class 3 rupees 3 annas.

Her Majesty's ship Nelson, now in Melbourne Harbor, has been ordered to be sold by the Admiralty. She was built in 1814, and was then the largest line-of-battle ship in the British navy. Her oak timbers are said to be as sound as when they were put in.

Piræus, the principal shipping port of Greece, is becoming of increased commercial importance. The construction of two dry docks 130 and 90 meters long respectively, to enable ships to be cleaned and repaired, has at last been decided upon and the contract has been let. The docks are to be built in the little roadstead of Canthare, situated near the entrance of the port, and the total cost of the two docks is estimated at £65,575. From this most useful undertaking, both commercial and economical advantages are likely to result, as no doubt all ships which hitherto had to proceed to Taranto, in Italy, to be cleaned will make use of these docks. There is at present only one floating dock at Salamis, with a capacity of about 2,500 tons.

On the 3d and 16th of each month an express train will leave St. Petersburg (Russia) for Tomsk (Siberia), the journey taking six days. The train is composed of cars having compartments each holding four passengers. Each passenger has a folding table for his own use. The library contains the latest works on Siberia. The cars are lighted by electricity and heated by hot water. From each compartment bell wires lead to the dining car and to the conductor's compartment. In the sleeping compartments portable electric lamps are provided. The parlor car contains the library, a piano, chess board, tables, and smoking requisites. The air is cooled before entering the car. Baths and gymnastic apparatus, such as dumb-bells, enable the traveler to better resist the effects of the long journey. It is not intended that regular meals should be taken in the dining or restaurant car, but arrangements are made for ordering meals at stations.—Oesterreichische Monatschrift für den öffentlichen Baudienst.

A feat unique in locomotive building, in order to meet the necessities of war, says The Railway World, has been accomplished at the Baldwin Locomotive Works in Philadelphia. An extraordinary effort had to be made to turn out four engines for the British government's imperative requirements in the quicker movement of troops, provisions, and munitions of war over the Soudan Railway in Lower Egypt. No European locomotive works could approximate the speed which John Bull required. So the Baldwins were asked what they could do in the emergency. They could build the locomotives in less than half the time, they said, that had been indicated as England's best. They got the contract, and they actually have constructed the engines in thirty-one days, or less than one-fourth the time that any concern east of the Atlantic would have required. It is an object lesson to all the world as to what the United States can do in the way of hustling when an emergency necessitates it. Even this time could have been beaten had the Baldwins been told at the start how great was the emergency.

A wanton waste of natural gas has occurred in connection with oil well drilling in America. The law says natural gas is not to be willfully wasted, but a landed curmudgeon says, "I have a perfect right to do as I will with mine own." The Supreme Court of Indiana, however, has administered the law made to meet such cases in no uncertain manner, and has shown to the contrary. Brushing aside all technicalities, the court went straight to the point, as the following extract from the judgment shows: "It is true that natural gas, when reduced to actual possession by the landowner, when drawn into his well, pipes, tanks, or other receptacles, thereby becomes his personal property, subject to his dominion. But the rule that the owner has the right to do as he pleases with or upon his own property is subject to many limitations and restrictions, one of which is that he must have due regard for the rights of others. Appellee's counsel have conceded that the pressure in gas wells since the discovery of gas in this State has fallen from 350 to 150 pounds. This very strongly indicates the possibility, if not the probability, of exhaustion. In the light of these facts, one who recklessly, defiantly, persistently, and continuously wastes natural gas, and boldly declares his purpose to continue to do so, as the complaint charges appellee with doing, all of which it admits to be true, by its demurrer, ought not to complain of being branded as the enemy of mankind."

The highly commendable plan of having an experimental and testing department has been adopted by the Pennsylvania Railroad Company. Not only will this be of advantage to itself, but to others, for it proposes to lend its aid in the work of practically solving various mechanical problems. The company has already laid a five mile track for the purpose of making these experiments, which is placed in a convenient region for the accurate testing of various plans and inventions, the remedy of defects and the careful study of every appliance which anyone may offer for inspection or test. The tracks, says The Philadelphia Press, have been laid down in East Pittsburg, almost parallel with the Pennsylvania line, and in the valley beneath those tracks the Westinghouse Works are situated. In those vast yards a system of electric propulsion has been in use for several years. By it the freight cars, which are switched into the yard, have been hauled with economy, ease, and method. It is what is known as the button system. The third-rail system is also to be tested in every detail. The tracks which the Pennsylvania Railroad has established, and which the Westinghouse Company is utilizing with an electric car, are supplemented by two interior rails; that is to say, it is not a single third-rail system, but is what may be called the double third-rail system. This system is now being tested upon these tracks for the purpose of determining whether the element of danger can be completely eliminated, and if so, whether the system can be operated as economically and as satisfactorily in other ways as the third-rail system with the live rail.

ELECTRICAL NOTES.

The Edison Company, which works the tramways for the municipality of Milan, will in the next few months bring in from the River Adda, at Paderino, 10,000 horse power. Six turbines, each 2,160 horse power, with a seventh as a reserve, will develop the power and convey to the seven dynamos. The current will be carried by overhead wires from Paderino to Milan, a distance of 20 miles. It is estimated that the loss of power will only be 9 per cent. in transit.

An attempt has been made at the little port of Ploumanach (Côtes-du-Nord), France, to utilize the tides for motive purposes. This has been rendered the easier since at high tide the water overflows into some natural pools at a much lower level separated from the sea by a kind of bank. This drop of water is used to drive a water wheel to which a dynamo is geared. By the use of accumulators a constant supply of electrical energy is thus available.

It is reported that King Leopold, of Belgium, has commissioned R. Dorsey Mohun, formerly United States consul and commercial agent in the Congo Free State, and who has since occupied a similar position at Zanzibar, to build a telegraph line from Lake Tanganyika to Wadelai, on the upper Nile, by way of Nyangwe and Stanley Falls. Mr. Mohun, it is added, is to be allowed a free hand in the selection of his staff, and will employ American and British engineers.

The Electrical Age says that the largest printing press ever built is being driven by a Crocker-Wheeler motor. This press was constructed by R. Hoe & Company, and is an octuple, stereotype perfecting press and folder. It prints, folds, counts, and delivers 96,000 eight-page newspapers in an hour. A 75 horse power motor, built by the Crocker-Wheeler Electric Company, of Ampere, N. J., and New York, has been installed under the floor for direct connection to the gigantic press above it.

The X rays have been applied by Messrs. Haycock and Neville to the study of the structure of metallic alloys, their paper on the subject having been presented to the Cambridge Philosophical Society. When the alloy is composed of two metals of different transparencies, radiographs of thin plates show the separation of the two during solidification. Thus an alloy of aluminum and gold shows on solidification a precipitate of the compound $AuAl_2$, which separates out in octahedral crystals.—American Electrician.

A device is described in The Street Railway Journal for catching the trolley pole when the trolley wheel leaves the wire, so as to prevent injury to the overhead construction, etc. The rope attached to the pole is wound on a reel in the catcher, and is held taut by a coiled spring which yields to slow movements; but if the pole rises suddenly, as when the wheel runs off the wire, the reel revolves rapidly and throws out dogs which instantly stop the motion. The catcher is usually fixed on the dashboard of the car.

The largest 60-cycle rotary converter yet constructed has been installed by the Pennsylvania Heat, Light, and Power Company, Philadelphia, Pa. It is a 16-pole machine of 400 k.w. capacity, running at 450 revolutions per minute. It was designed to convert an alternating two-phase current of 60 cycles frequency and voltage between 165 and 220 volts into a continuous current of 225 to 300 volts. It stands 8 feet high on a base 8 feet 4 inches by 8 feet 6 inches. To obtain the necessary variation in the continuous current of the rotary converter, two special 60-cycle transformers, each 200 k.w. capacity, have been furnished. These operate with a primary potential of 2,000 volts and a secondary potential varying from 165 to 220 volts. The variation is obtained through a dial switch over which passes a central plate, cutting out or throwing in more or less turns of the primary winding, and thereby varying the secondary potential.

In a paper presented to the Académie des Sciences, M. P. Janet gives the results of researches upon the temperature of incandescent filaments. The method used consisted of measuring the resistance of the lamp as a function of the e.m.f. across its terminals, and the variation with time of the resistance of the lamp while cooling. From these data the curve of watts radiated in any time and the heat units given off by the lamp may be deduced. Then by weighing the filament the temperature can be deduced from Violle's formula. The experiments were made on four lamps of 10 c. p. at 65 volts. The results showed temperatures of 1,720, 1,610, 1,630 and 1,620 degrees (Centigrade) for the various lamps, which are remarkably accordant. The principal difficulty with the method outlined is that of accurately weighing the very light filament, but the author suggests that to avoid this low voltage lamps with thick filaments can be employed for future work.

If we mistake not, says Electricity, Dr. Fridtjof Nansen, in his last attempt to reach the North Pole, had the "Fram" equipped with a specially designed windmill, which, when operating, drove a dynamo and furnished the necessary current for lighting purposes. An aermotor erected on the roof of a building in Park Place, New York, has been for some time successfully driving a dynamo in connection with a storage battery plant, the current from which has been utilized for incandescent lighting. From this it will be seen that there is nothing very new in the application of windmills to the driving of dynamos. There are probably several reasons why the windmill or aermotor has not been more universally adopted for the above purpose. In the first place, such a motor is always more or less uncertain, and cannot always be depended upon. There may be a calm just at the time it is found necessary to recharge the batteries, or the batteries may be in use when a breeze springs up. This would necessitate having two sets of batteries at a considerable cost. Another reason why aermotors have not been more extensively adopted is probably due to the fact that currents can now be generated with steam as a motive power very economically, especially in large quantities. The erecting of an aermotor and the installation of a number of storage batteries with a dynamo mean a considerable outlay of money, especially when the cost of maintenance and renewal is taken into account.

MISCELLANEOUS NOTES.

In Japan there is no market for bicycle lamps, as cycling after sunset is prohibited.—Le Chasseur Français.

At present the Pintsch system of gas lighting is in use on 85,600 cars and locomotives in the world. In but few of the countries where this method of lighting has been used has it been applied to the locomotive, and Germany is the only country that has so applied it to any considerable extent, there being at the end of last year 2955 locomotives in that country lighted by the Pintsch system. Brazil comes next with but thirty-one such installations, and it is furthermore worthy of note that Germany is the only country where the number of such installations has increased from the end of 1896 to the end of 1897, the increase in this case being 166. Last year there were 6089 coaches equipped, and it is of interest to note in what countries the increase has been the greatest during the year 1897. In 1888 there were but 11,422 installations on cars and locomotives. In five years the number had increased to 26,100, and in ten years to 54,175.

Quite a number of experiments have been made in manufacturing bicycle pedal frames from aluminum by drop-forging them, and they have proved very successful, owing to the lightness of the metal, the color, and the ease with which they can be made. This same process of manufacture can be extended to the brake-shoes, brake-handles, handle-bars, etc. In drop-forging aluminum the dies should be made with considerable clearness, and vaseline used as a lubricant, says The Aluminum World. Naturally there is not as much force required to work aluminum as in drop-forging steel, and less time is consumed in making the forging. Care should be taken, however, to use plenty of lubricant, so that the metal will not stick to the dies. The effect of alloying aluminum which is to be drop-forged is to harden the metal considerably; the higher alloys give the best results up to 15 per cent. of alloying material. No zinc should be used in alloying aluminum which is to be drop-forged, because the tendency of zinc is to make the metal brittle.

Carborundum, the new abrasive, manufactured in large quantities at Niagara Falls, is to be spread on cloth and paper and possibly leather by the manufacturers, who will build an addition to their plant to provide the proper facilities. This addition will consist of a three-story brick structure 50 by 228 feet at the foundation, located adjoining the carborundum manufacturing plant on the lands of the Niagara Falls Power Company. This departure will place carborundum in direct competition with the emery, garnet, and flint cloth manufacturers of the United States, of which there are seven or eight. While it has long been recognized that there were great possibilities for carborundum in this field, the manufacturers have been busy developing the wheel and kindred industries. In the new field it is highly probable that the consumption of carborundum will exceed the amount used in wheel and other trades, and it is likely to lead to a large increase of the output capacity of the Niagara Falls carborundum plant. In fact, it is understood that the Carborundum Company are already preparing to enlarge their furnace capacity.

French exports showed the following increase in 1897 over 1896:

Great Britain	$29,000,000
Italy	7,300,000
Germany	7,100,000
United States	4,300,000
Belgium	3,200,000
Switzerland	2,200,000

Exports to the following countries showed a decrease:

Brazil	$1,600,000
Argentina	900,000
Spain	600,000

French imports from the following countries increased in 1897:

United States	$24,700,000
Russia	8,300,000
Turkey	3,000,000

A decrease occurred in imports from:

Spain	$10,300,000
Great Britain	4,300,000

The total exports show an increase of $55,000,000 over 1896, and the total imports an increase of $40,300,000.—Uhland's Wochenschrift.

The bright gloss of silk may be imparted to cotton and also to wool by mechanical and by chemical treatment, with caustic alkalies, sulphuric acid, nitric acid, zinc chloride, etc. The name is due to Mercer, who as early as 1844 employed soda lye for this purpose. The fiber thus treated contracts and shows a greater affinity for the dye. In the Moniteur Scientifique, Gassman gives an interesting review of the various mercerization processes. Zibrowski takes a mixture of one part of caustic soda and three of lime, instead of soda simply. Thomas and Prevost stretch the material under mercerization in order to avoid the shrinking. Dollfus, Mieg & Company, of Belfort, neutralize the shrinking by subsequent stretching of the wet material. The increased affinity for colors has very widely been utilized. The gloss may be produced by means of collodion, and afterward of B-naphthol disulphonate of sodium (Jacob). Boursier employs a mixture of gelatine and nitrocellulose; Heberlein and others prefer other collodion preparations. Ungnad treats the texture with an alkaline solution of silk; formerly silk solutions in fine chloride had been used. Clad & Company mercerize wool; it is washed first in dilute hydrochloric acid, then for twenty minutes in sodium hypochlorite, and again in hydrochloric acid. The wool turns yellow, and is bleached with stannous chloride. Koethe treats wool with bromine; the dye works at Höchst proceed similarly. Depouilly shrinks silk fiber by treatment with acids. Mommer & Company and also Eugene Crépy do not resort to any chemicals. They press the stuff between rolls on which a satin pattern has been produced by electro-chemical action.

IS THERE ANY EXCUSE FOR COLLISIONS AT SEA?

MEANS FOR DETECTING THE PRESENCE OF A VESSEL OR ICEBERG; HOW THEIR MOVEMENTS MAY BE FOLLOWED.

To the Editor of the SCIENTIFIC AMERICAN:

The recent "Bourgogne" disaster, connected with such heavy loss of life, such fearful dramatic scenes, where egotism was predominating to such extent that beastly, barbarous means were resorted to in butchering and annihilating the weaker element, has caused a deep and everlasting impression upon its survivors, upon everybody endowed with a fellow feeling. The motive of self-preservation, stimulated and incited to the highest pitch by the act of some one drawing a knife in order to quickly make for safety, caused them to become frantic, where they could have easily launched a larger number of lifeboats. The loss of life due to this fact, and due to the murdering of many who vainly tried to save themselves, is perhaps doubled or trebled from what it would have been, had proper steps been taken and had order been maintained.

Some years ago, I, myself, was a witness of a collision some sixty miles off the coast of England. It occurred at about eight o'clock in the evening, with the moon brightly shining. Towed into an English port, we remained there for three days until the damage was repaired. This was, however, a trivial affair, as no lives were lost; but the scenes on board gave me an idea of how easily a few persons losing their self-control may affect a large crowd. It is hard to describe the strain and exertion one undergoes when in such a position that escape from impending danger seems almost entirely cut off. I must attribute great credit for the amount of fortitude my mother displayed; assembling her children around her, she said: "Stay with me; if it must be, let us die together."

The average person lacks such coolness of mind in such critical moments, and in losing all self-control shakes that of those so far unaffected. It seems to me that travelers should be made familiar with the safety appliances on board, and I venture to express the hope that the Bourgogne disaster will not only cause the different navigation companies to give to their patrons practical lessons in using and applying such expedients; but also such further information as may be of benefit to them in case of accidents. As to the matter of lifeboats, improvements seem highly desirable, and particularly to quick and efficient means for launching them. Many lives were lost just on account of this deficiency. It should be made compulsory for each vessel to have a total carrying capacity of lifeboats exceeding by 10 or 20 per cent. the maximum number of passengers carried.

One of the New York dailies truly says: "So far as Atlantic liners are concerned, skill in naval architecture has rendered them proof against any storm that can blow and any sea that a storm can stir up. Even the failure of their engines means nothing more than inconvenience, for so scientifically are they constructed that even when adrift upon an angry sea, they are safe. But in fog they cannot see when other ships approach, and owing to natural laws, wrestled with by no less eminent scientists than Joseph Henry and Professor Tyndall, they cannot even hear without danger of being lured to destruction by echoes and by what the scientists have named fog's 'opacity' to sound."

This Bourgogne disaster has stimulated within me the desire of finding some such suitable means whereby collisions at sea may be avoided.

Before entering into a discussion of these, it may be in order to mention a few methods of signaling in use.

In a dense fog, of course auricular signals must be resorted to, and among these we have, with an approximate hearing distance in miles, the following:

The air siren	10–12	miles
The steam "	8–10	"
The trumpet	6	"
The bell	1	"

For receiving the sounds, the eophone, topophone, or similar instruments have been employed with more or less success. The object of these instruments being to furnish a means whereby to determine the direction from which the sound proceeds. The eophone consists of two bell-shaped receivers having a central diaphragm; the further end tapering down and being connected to ear tubes. The whole is mounted in a suitable manner, whereby it is possible to point the open ends in any direction desired. If now the sound waves impinge upon both of these diaphragms with equal strength, i. e., if each ear perceives the sound in a like manner, then of course the receivers point in the direction whence the sound proceeds. If, however, one ear perceives the sound more distinctly than the other, it follows that the true direction has not been found.

It is evident that both vessels must be active, not only in giving signals, but also in "attempting" to intercept them. The safety of a vessel, therefore, not only rests with its own crew, but largely depends upon the watchfulness of the other vessels.

A good deal of blind confidence is, therefore, placed in any stranger who may come along; it is not this alone which makes navigation dangerous during a heavy fog; it is made much more so on account of atmospheric conditions which, as yet, are not fully understood. At times it is impossible to perceive the sonorous signals when the steamer is near by, while the signal was plainly heard from some larger distance. As to the cause of this surprising interruption (seeming) in the propagation of sounds, investigations have been carried on by the United States, Germany, and France. The investigations made by Major Livermore, in compliance with the United States Admiralty, have thrown some light upon this subject. It has been deduced that obstructions to sound or an irregular formation of the coast not only affect the strength, but also the propagation of the same. Obstructions behind the source of sound will reinforce them in a similar manner, as a screen will reflect the light. Rain and snow have a great influence upon the direction of the sound.

It has been observed that under certain atmospheric and geological conditions, direction of wind, etc., a sound could not be heard near the surface of the water, while it was heard plainly some distance above it. In one experiment Major Livermore's vessel had been placed in such a position that the blowing of whistles, even the shooting of a cannon, could plainly be heard at one end of the vessel while it was impossible to perceive any sound at the other end, although the steam or smoke could be seen to arise. It seems, therefore, that under certain conditions sound waves may be projected upward to descend again at some distance and finally take up their original direction. No doubt this remarkable interruption has caused many accidents which could not be accounted for, and it would seem a vain task trying to devise means whereby to prevent the sound wave, as it may, perhaps, be termed (to use the expression of another writer), from sliding up this invisible inclined plane. Having not read any accounts of the foreign experiments, I am not in position to communicate thereupon.

At the first thought it seems that wireless telegraphy would meet all requirements for signaling. Reflecting upon this will soon convince us that each and every vessel afloat must be equipped with a complete set of apparatus. Even if their use were made compulsory, then again would the safety of a vessel largely be dependent upon the other vessels in a similar manner, as outlined above. Although the introduction of this kind of apparatus would make navigation safer, the location and movements of other vessels could, nevertheless, not be determined. Besides these there are icebergs and floating wrecks.

Taking all in all, it is desirable to find a means of indicating the nearness or approach of any object.

FIG. 1.

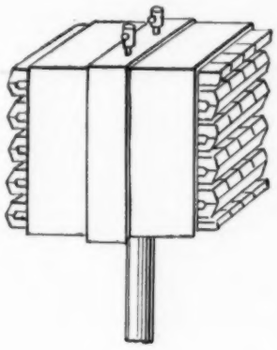
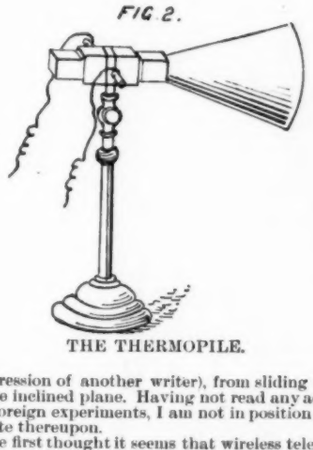


FIG. 2.



THE THERMOPILE.

It is well known that any object, when its temperature is higher or lower than that of the atmosphere surrounding the same, will either send forth heat radiations or else, in the other case, absorb heat from its surrounding medium. In the winter, we clothe ourselves so as to keep warm; in other words, we surround ourselves with a poor heat conductor, so as to diminish the heat radiation from our bodies to the atmosphere.

If we can construct an apparatus which is acted upon by such heat radiations, and if the apparatus be so sensitive that it will indicate the radiations, even if they be exceedingly weak, then we have a means which may be advantageously employed in navigation. As soon as we can intercept the radiations sent forth from a vessel, we need not depend upon our ear or eye to locate the same. A modification of the thermopile or the radiophone may be employed in connection with this problem.

A few remarks pertaining to these may be of interest. Seebeck, in 1821, discovered that an electric current is set up in a closed circuit consisting of different metals when their junctions would be maintained at different temperatures. The best effects have been subsequently obtained by the use of antimony and bismuth. A number of such metal strips, properly arranged, form the "thermopile." Sir William Thomson reasoned out and verified by experiment that an electromotive force is produced in a substance when unequally heated. Peltier discovered that there is a reversible heat production at the junction of the same substance at different temperatures or of different substances at the same temperature when an electric current is allowed to pass, so that a current flowing tends to cool the junction instead of heating it. This latter effect, the Peltier, is quite the reverse of the Seebeck effect, i. e., in one case a current is generated owing to the existence of different temperatures, while in the other case a difference of temperature is produced owing to the flow of a current. The available output of a thermopile depends, therefore, upon the difference of these effects. The current produced is proportional to the difference of temperature existing between the two surfaces of contact, i. e., of course, within limits.

With a modification of this apparatus Prof. Boys has been able to detect the heat of a candle at a quarter of a mile distance. Tyndall has used it for investigating the laws of radiant heat—one face of the exposed contacts being blackened and exposed to the source of radiation. Prof. Langley's modified thermopile, the bolometer, when used in connection with Lord Kelvin's galvanometer and employing Prof. Boys' most delicate quartz thread suspension and his extremely small mirror, would finally be so sensitive as to indicate a difference of less than $\frac{1}{1000000}$ degree Centigrade.

Fig. 1 shows the assembly of suitable metal strips, such as antimony and bismuth, surrounded by an insulating casing, forming the thermopile, the free ends being connected to binding posts.

Fig. 2 shows such a thermopile rigidly supported and provided with a conical attachment, being blackened on its inner surface, which preferably is not smooth. It serves the purpose of concentrating the radiations upon the exposed face of contacts, in that way augmenting the effects.

Fig. 3 shows part of an apparatus as proposed by me to the end of detecting the approach or nearness of any vessel, iceberg, or obstruction.

The two thermopiles, T, T^1, are surrounded by an insulating casing, C, and attached to a shaft, S, which may be revolved slowly. The insulated rings, R^1, R^2, R^3, serve to establish a permanent connection of the thermopiles with the brushes, B^1, B^2, B^3, from where wires may be led to the pilot house to the observation or indicating apparatus. The thermopiles are inclosed in a suitable compartment such as to exclude all air currents and to afford protection from the radiations of the sun and the vessel itself. For this reason the whole is mounted on the outer side of the vessel. A flat ⊃-shaped double walled casing (not shown) surrounds the compartment, C^1; the outer chamber of the former is filled with alum solution for the purpose of intercepting radiations due to the rays of the sun, either striking directly or being reflected from the water and also for intercepting those which are emitted from the vessel itself. The inner chamber may be attached to a continuous water supply so as to remove all heat which the alum cell may have absorbed and also to maintain the chamber, C^1, at a constant temperature.

Fig. 4 shows a diagram of connections. A junction of two of the free ends of the thermopiles, T and T^1, is

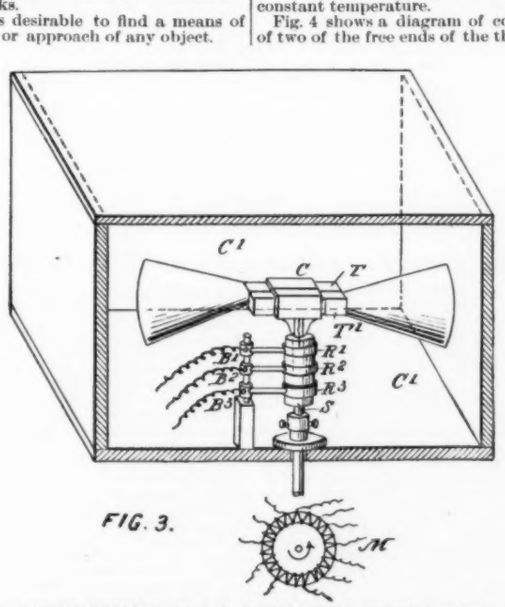


FIG. 3.

DOUBLE ROTATING THERMOPILE FOR DETECTING THE PROXIMITY OF BODIES.

led to the middle ring and thence over the brushes to the two galvanometers, G^1, G^2, here shown of the D'Arsonval type. The other terminals of the galvanometer coils, C^1, C^2, connect through adjustable resistances, R R^1, R R^2, and switches, S^1, S^2, to their respective outside rings, R^1 and R^3.

For observation a galvanometer scale may be employed, or, perhaps, an automatic indicating device, as shown in Fig. 4. A light aluminum arm, A, fastened to the movable galvanometer coil swings between two adjustable contacts, D^1, D^2, or D^3 and D^4. A local circuit, including batteries, E, and bells is completed, should this arm be turned through a small angle. For indi-

cating the exact position of the thermopile, a large number of contrivances may be constructed. In these it should be aimed at to have a position indicator, *P*, operated by the same current which revolves the thermopiles.

Suppose, now, that in foggy weather, when we cannot see, when we are in fear of being deceived by the sound, we start this apparatus and make ourselves independent of the watchfulness of other vessels.

A vessel approaches; we are not aware of it—the radiations given out by the same are too weak to affect the apparatus; we come nearer each other; a stronger current is set up in one of the thermopiles, at the moment it points in the direction whence the radiations proceed. Instantaneously the galvanometer coil is slightly turned, the aluminum arm makes contact, and causes one of the bells to give a short ring. This happens once at every half revolution, as then the second thermopile becomes active. As the distance between the vessels diminishes, the effect will naturally increase and a contact is made covering a longer period of time. Watching the instantaneous position of the revolving position indicator, *P*, at the moment the bell rings, and simultaneously cutting out one of the thermopiles by switch, S^1 or S^2, will immediately give us an approximate knowledge of the direction from which the vessel is approaching. To obtain a more accurate knowledge, the adjustable resistance may now be manipulated. It being in circuit with the galvanometer, the current from the thermopile will, of course, be cut down. Under normal conditions, i. e., with the resistance cut out, the bell will operate for a certain length of time, depending upon the amount of radiations sent forth from the nearing vessel, as well as the time of exposure of the thermopile to their influence. This again depends upon the speed of the revolving thermopiles. The purpose of the resistance, then, is to cut down the action of the thermopile to such extent that the aluminum arm makes contact only at the instant the maximum current is being produced. As this can occur only when the thermopile points directly toward the strange vessel, its position is immediately ascertained by simply moving the contact lever until the bell gives the shortest obtainable ring. For all ordinary purposes, the observation of the slowly moving position indicator arm, *P*, will, therefore, be sufficient. A small adjustable pointer, P^2, which may be swung around the outside casing of the position indicator, *P*, may serve to fix this position.

By the increased or diminished action of the thermopiles we know whether a vessel approaches or whether it recedes; by watching the position indicator we know whether the vessel is moving toward the right or toward the left. These means therefore enable us not only to ascertain the presence of a vessel, but also to follow its movements, and all this is accomplished by simply adjusting the rheostat, listening to the bell, and watching the position indicator.

Safely passing the vessel, we now come near an iceberg. The effect is similar as before; the current produced in the thermopile is, however, now flowing in the opposite direction, causing the coil to turn the opposite way and also a different bell to give its warning signal.

It is possible therefore to tell the nature of the obstruction, whether it be a vessel or an iceberg. In the case of a floating wreck, more difficulty is to be expected, as its temperature will not differ very much from that of the surrounding atmosphere. It may, however, be that if its entire exposed surface is in moist condition, a sufficient fall of temperature is produced to affect the apparatus, and to do likewise on account of radiations given out due to exposure to the rays of the sun. For the same reasons it may also be possible to tell when nearing a coast.

The double thermopile is proposed for the purpose of increasing the action of the apparatus, as then it can be revolved at a slower speed, in that way giving a longer exposure to the radiations, while at the same time the vessel is better protected. A combination of four of these would undoubtedly improve the effects considerably, as the speed may then be cut down still lower. A plurality of thermopiles suitably arranged would not require to be revolved. Of course each side of the vessel should be provided with a complete apparatus.

The galvanometer should be mounted so as to be free from vibration.

Now, a few remarks touching upon the radiophone. Berzelius, in 1817, discovered selenium. Knox, in 1837, found that it was an electrical conductor. May discovered that its conductivity is much influenced by light. In their experiments physicists used the galvanometer, while Bell used the telephone. Bell and Tainter subsequently constructed the photophone, its receiver consisting of metal disks insulated from each other and covered with selenium. A ray of light reflected from a mirror diaphragm against which is spoken, after passing through suitable concentrating lenses is reflected to a distant parabolic concave mirror and thence focused onto a selenium cell, which has a telephone receiver and battery in its circuit. Sound was in this manner transmitted over a beam of light. Later experiments showed that sound can be transmitted more efficiently by non-luminous heat rays. Mercadier then constructed the radiophone. In this instrument soot or lamp black is made use of, forming a bridge between the two electrodes which are in circuit with battery and telephone. In some experiments Graham Bell used a bottle or test tube, covered or filled with soot. Throwing the focused light on these would produce a sound if the rays be of intermittent nature.

It is a fact, then, that heat rays will affect the conductivity of such radiophonic apparatus. Whether their application to the above end could be accomplished seems at this moment difficult to answer. If its sensitiveness can be brought up to that of the thermopile, and if no serious mechanical difficulties be met in maintaining the soot in the proper place, then it would become a simple matter to also apply the radiophone for the purpose stated.

My conception of applying these means dates back to July 7, 1898. I will not commit myself in stating that such methods as outlined above are absolutely feasible under all conditions, nevertheless they appear worthy of a careful perusal and study. Certainly a large number of factors must be dealt with in the attempt of solving this problem, so fascinating and interesting, such as, for instance, the effects of warm winds, the Gulf Stream, and others.

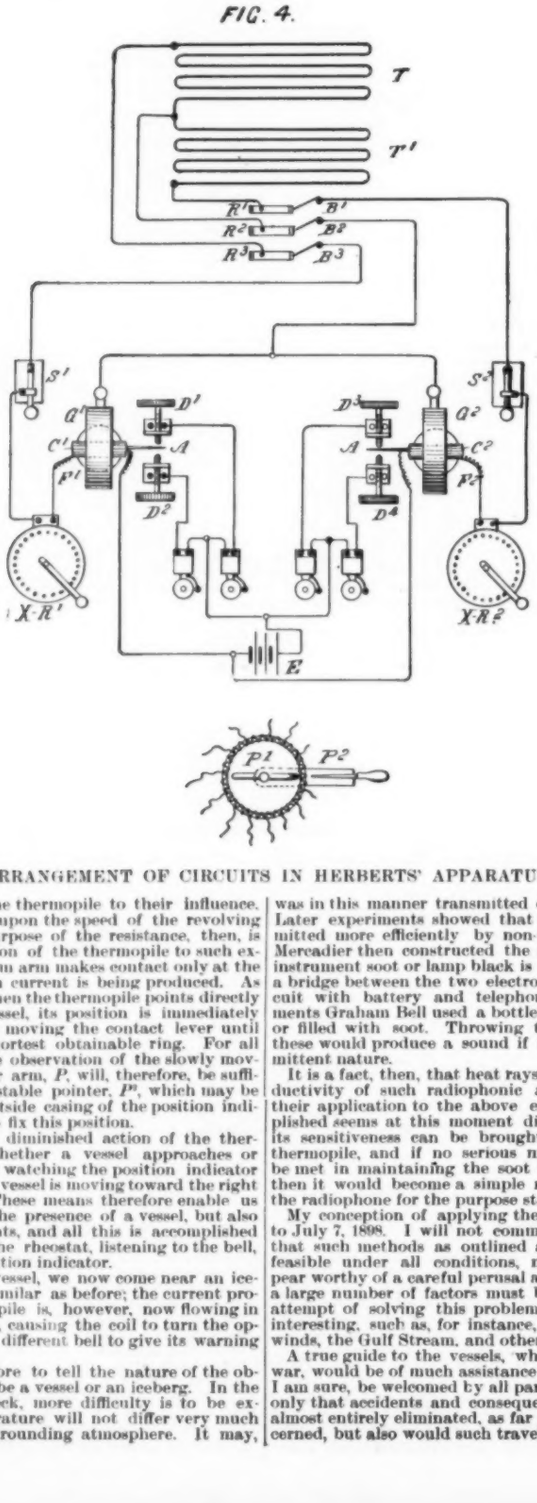
A true guide to the vessels, whether in peace or in war, would be of much assistance to the seamen and, I am sure, be welcomed by all parties concerned. Not only that accidents and consequent deaths would be almost entirely eliminated, as far as collisions are concerned, but also would such traveling lose much of its fears. The day of the foghorn would then be gone. The seaman, the traveler, the navigation company, in fact everybody, will be benefited by its realization, as its introduction would largely influence commerce, and bring the nations into closer and more intimate contact.

Seeing all these possibilities, I most heartily advance these rather incomplete ideas and hope that the press here, as well as abroad, will contribute its share in discussing the subject. I also express the hope that all those interested will not withhold their ideas, and, further, that influential parties will lend their aid to bring about a realization of this problem.

Hermann Herberts.

225 Washington Street, Newark, N. J., July 18, 1898.

FIG. 4.



ARRANGEMENT OF CIRCUITS IN HERBERTS' APPARATUS.

OFFICIAL REPORTS OF THE DESTRUCTION OF THE SPANISH FLEET OFF SANTIAGO.

Admiral Sampson's Report.

United States Flagship "New York," First Rate,
Off Santiago de Cuba, Cuba, July 15, 1898.

Sir: 1. I have the honor to make the following report upon the battle with and the destruction of the Spanish squadron, commanded by Admiral Cervera, off Santiago de Cuba, on Sunday, July 3, 1898.

2. The enemy's vessels came out of the harbor between 9:35 and 10 A. M., the head of the column appearing around Cay Smith at 9:31, and emerging from the channel five or six minutes later.

3. The positions of the vessels of my command off Santiago at that moment were as follows: The flagship "New York" was four miles east of her blockading station and about seven miles from the harbor entrance. She had started for Siboney, where I intended to land, accompanied by several of my staff, and go to the front to consult with Gen. Shafter. A discussion of the situation and a more definite understanding between us of the operations proposed had been rendered necessary by the unexpectedly strong resistance of the Spanish garrison of Santiago. I had sent my chief of staff on shore the day before to arrange an interview with Gen. Shafter, who had been suffering from heat prostration. I made arrangements to go to his headquarters, and my flagship was in the position mentioned above when the Spanish squadron appeared in the channel. The remaining vessels were in or near their usual blockading positions, distributed in a semicircle about the harbor entrance, counting from the eastward to the westward, in the following order: The "Indiana," about a mile and a half from shore; the "Oregon"—the "New York's" place between these two—the "Iowa," "Texas," and "Brooklyn," the latter two miles from the shore west of Santiago. The distance of the vessels from the harbor entrance was from two and one-half to four miles, the latter being the limit of day blockading distance. The length of the arc formed by the ships was about eight miles. The "Massachusetts" had left at 4 A. M. for Guantanamo for coal. Her station was between the "Iowa" and "Texas." The auxiliaries "Gloucester" and "Vixen" lay close to the land and nearer the harbor entrance than the large vessels, the "Gloucester" to the eastward and the "Vixen" to the westward. The torpedo boat "Ericsson" was in company with the flagship, and remained with her during the chase until ordered to discontinue, when she rendered very efficient service in rescuing prisoners from the burning "Vizcaya." I inclose a diagram showing approximately the positions of the vessels as described above.

4. The Spanish vessels came rapidly out of the harbor, at a speed estimated at from eight to ten knots, and in the following order: "Infanta Maria Teresa" (flagship), "Vizcaya," "Cristobal Colon," and the "Almirante Oquendo." The distance between these ships was about 800 yards, which means that, from the time the first one became visible in the upper reach of the channel until the last one was out of the harbor, an interval of only about twelve minutes elapsed. Following the "Oquendo," at a distance of about 1,200 yards, came the torpedo boat destroyer "Pluton," and after her the "Furor." The armored cruisers, as rapidly as they could bring their guns to bear, opened a vigorous fire upon the blockading vessels, and emerged from the channel shrouded in the smoke from their guns.

5. The men of our ships in front of the port were at Sunday "quarters for inspection." The signal was made simultaneously from several vessels, "Enemy's ships escaping," and general quarters was sounded. The men cheered as they sprang to their guns, and fire was opened probably within eight minutes by the vessels whose guns commanded the entrance. The "New York" turned about and steamed for the escaping fleet, flying the signal "Close in toward harbor entrance and attack vessels," and gradually increasing speed, until toward the end of the chase she was making sixteen and one-half knots, and was rapidly closing on the "Cristobal Colon." She was not at any time within range of the heavy Spanish ships, and her only part in the firing was to receive the undivided fire from the forts in passing the harbor entrance and to fire a few shots at one of the destroyers, thought at the moment to be attempting to escape from the "Gloucester."

6. The Spanish vessels, upon clearing the harbor, turned to the westward in column, increasing their speed to the full power of their engines. The heavy blockading vessels, which had closed in toward the Morro at the instant of the enemy's appearance, and at their best speed, delivered a rapid fire, well sustained and destructive, which speedily overwhelmed and silenced the Spanish fire. The initial speed of the Spaniards carried them rapidly past the blockading vessels, and the battle developed into a chase, in which the "Brooklyn" and "Texas" had at the start the advantage of position. The "Brooklyn" maintained this lead. The "Oregon," steaming with amazing speed from the commencement of the action, took first place. The "Iowa" and "Indiana," having done good work, and not having the speed of the other ships, were directed by me in succession, at about the time the "Vizcaya" was beached, to drop out of the chase and resume blockading stations. These vessels rescued many prisoners. The "Vixen," finding that the rush of the Spanish ships would put her between two fires, ran outside of our column and remained there during the battle and chase.

7. The skillful handling and gallant fighting of the

"Gloucester" excited the admiration of every one who witnessed it, and merits the commendation of the Navy Department. She is a fast and entirely unprotected auxiliary vessel—the yacht "Corsair"—and has a good battery of light rapid-fire guns. She was lying about two miles from the harbor entrance, to the southward and eastward, and immediately steamed in, opening fire upon the large ships. Anticipating the appearance of the "Pluton" and "Furor," the "Gloucester" was slowed, thereby gaining more rapidly a high pressure of steam, and when the destroyers came out she steamed for them at full speed, and was able to close at short range, when her fire was most deadly and of great volume. During this fight the "Gloucester" was under the fire of the Socapa battery. Within twenty minutes from the time they emerged from Santiago Harbor the careers of the "Furor" and the "Pluton" were ended and two-thirds of their people killed. The "Furor" was beached and sunk in the surf; the "Pluton" sank in deep water a few minutes later. The destroyers probably suffered much injury from the fire of the secondary batteries of the battleships "Iowa," "Indiana," and the "Texas," yet I think a very considerable factor in their speedy destruction was the fire at close range of the "Gloucester's" battery. After rescuing the survivors of the destroyers, the "Gloucester" did excellent service in landing and securing the crew of the "Infanta Maria Teresa."

8. The method of escape attempted by the Spaniards, all steering in the same direction, and in formation, removed all tactical doubt or difficulties, and made plain the duty of every United States vessel to close in, immediately engage, and pursue. This was promptly and effectively done. As already stated, the first rush of the Spanish squadron carried it past a number of the blockading ships, which could not immediately work up to their best speed; but they suffered heavily in passing, and the "Infanta Maria Teresa" and the "Oquendo" were probably set on fire by shells fired during the first fifteen minutes of the engagement. It was afterward learned that the "Infanta Maria Teresa's" fire main had been cut by one of our first shots and that she was unable to extinguish fire. With large volumes of smoke rising from their lower decks aft, these vessels gave up both fight and flight, and ran in on the beach, the "Infanta Maria Teresa" at about 10:15 A. M., at Nima, six and one-half miles from Santiago Harbor entrance, and the "Almirante Oquendo" at about 10:30 A. M., at Juan Gonzales, seven miles from the port.

9. The "Vizcaya" was still under the fire of the leading vessels; the "Cristobal Colon" had drawn ahead, leading the chase, and soon passed beyond the range of the guns of the leading American ships; the "Vizcaya" was soon set on fire, and at 11:15 she turned inshore and was beached at Aserradero, fifteen miles from Santiago, burning fiercely, and with her reserves of ammunition on deck already beginning to explode. When about ten miles west of Santiago the "Indiana" had been signaled to go back to the harbor entrance, and at Aserradero the "Iowa" was signaled to "Resume blockading station." The "Iowa," assisted by the "Ericsson" and the "Hist," took off the crew of the "Vizcaya," while the "Harvard" and the "Gloucester" rescued those of the "Infanta Maria Teresa" and the "Almirante Oquendo." This rescue of prisoners, including the wounded, from the burning Spanish vessels, was the occasion of some of the most daring and gallant conduct of the day. The ships were burning fore and aft, their guns and reserve ammunition were exploding, and it was not known at what moment the fire would reach the main magazines. In addition to this, a heavy surf was running just inside of the Spanish ships. But no risk deterred our officers and men until their work of humanity was complete.

10. There remained now of the Spanish ships only the "Cristobal Colon," but she was their best and fastest vessel. Forced by the situation to hug the Cuban coast, her only chance of escape was by superior and sustained speed. When the "Vizcaya" went ashore, the "Colon" was about six miles ahead of the "Brooklyn" and the "Oregon;" but her spurt was finished, and the American ships were now gaining upon her. Behind the "Brooklyn" and the "Oregon" came the "Texas," "Vixen," and "New York." It was evident from the bridge of the "New York" that all the American ships were gradually overhauling the chase and that she had no chance of escape. At 12:50 the "Brooklyn" and the "Oregon" opened fire and got her range, the "Oregon's" heavy shell striking beyond her, and at 1:20 she gave up without firing another shot, hauled down her colors, and ran ashore at Rio Torquino, forty-eight miles from Santiago. Capt. Cook, of the "Brooklyn," went on board to receive the surrender. While his boat was alongside I came up in the "New York," received his report, and placed the "Oregon" in charge of the wreck to save her if possible, and directed the prisoners to be transferred to the "Resolute," which had followed in the chase. Commodore Schley, whose chief of staff had gone on board to receive the surrender, had directed that all their personal effects should be retained by the officers. This order I did not modify. The "Cristobal Colon" was not injured by our firing, and probably is not much injured by beaching, though she ran ashore at high speed. The beach was so steep that she came off by the working of the sea. But her sea valves were opened and broken treacherously, I am sure, after her surrender, and despite all efforts, she sank. When it became evident that she could not be kept afloat, she was pushed by the "New York" bodily upon the beach, the "New York's" stem being placed against her for this purpose, the ship being handled by Capt. Chadwick with admirable judgment, and sank in shoal water, and may be saved. Had this not been done, she would have gone down in deep water and would have been to a certainty a total loss.

11. I regard this complete and important victory over the Spanish forces as the successful finish of several weeks of arduous and close blockade, so stringent and effective during the night that the enemy was deterred from making the attempt to escape at night, and deliberately elected to make the attempt in daylight. That this was the case I was informed by the commanding officer of the "Cristobal Colon."

12. It seems proper to briefly describe here the manner in which this was accomplished. The harbor of Santiago is naturally easy to blockade, there being but one entrance, and that a narrow one; and the deep water extending close to the shore line presenting no difficulties of navigation outside of the entrance. At the time of my arrival before the port—June 1—the moon was at its full, and there was sufficient light during the night to enable any movement outside of the entrance to be detected; but with the waning of the moon and the coming of dark nights, there was opportunity for the enemy to escape, or for his torpedo boats to make an attack upon the blockading vessels. It was ascertained with fair conclusiveness that the "Merrimac," so gallantly taken into the channel on June 3, did not obstruct it. I therefore maintained the blockade as follows: To the battleships was assigned the duty, in turn, of lighting the channel. Moving up to the port at a distance of from one to two miles from the Morro, dependent upon the condition of the atmosphere, they threw a searchlight beam directly up the channel, and held it steadily there. This lighted up the entire breadth of the channel for half a mile inside of the entrance so brilliantly that the movement of small boats could be detected. Why the batteries never opened fire upon the searchlight ship was always a matter of surprise to me; but they never did. Stationed close to the entrance of the port were three packet vessels, usually converted yachts, and, when they were available, one or two of our torpedo boats. With this arrangement there was at least a certainty that nothing could get out of the harbor undetected. After the arrival of the army, when the situation forced upon the Spanish admiral a decision, our vigilance increased. The night blockading distance was reduced to two miles for all vessels, and a battleship was placed alongside the searchlight ship, with her broadside trained upon the channel, in readiness to fire the instant a Spanish ship should appear. The commanding officers merit the greatest praise for the perfect manner in which they entered into this plan and put it into execution. The "Massachusetts," which, according to routine, was sent that morning to coal at Guantanamo, like the others, had spent weary nights upon this work, and deserved a better fate than to be absent that morning. I inclose, for the information of the department, copies of orders and memoranda issued from time to time, relating to the manner of maintaining the blockade.

13. When all the work was done so well, it is difficult to discriminate in praise. The object of the blockade of Cervera's squadron was fully accomplished, and each individual bore well his part in it—the commodore in command of the second division, the captains of ships, their officers and men. The fire of the battleships was powerful and destructive, and the resistance of the Spanish squadron was, in great part, broken almost before they had got beyond the range of their own forts. The fine speed of the "Oregon" enabled her to take a front position in the chase, and the "Cristobal Colon" did not give up until the "Oregon" had thrown a thirteen-inch shell beyond her. This performance adds to the already brilliant record of this fine battleship and speaks highly of the skill and care with which her admirable efficiency has been maintained during a service unprecedented in the history of vessels of her class. The "Brooklyn's" westerly blockading position gave her an advantage in the chase, which she maintained to the end, and she employed her fine battery with telling effect. The "Texas" and the "New York" were gaining on the chase during the last hour, and had any accident befallen the "Brooklyn" or the "Oregon," would have speedily overhauled the "Cristobal Colon." From the moment the Spanish vessel exhausted her first burst of speed the result was never in doubt. She fell, in fact, far below what might reasonably have been expected of her. Careful measurements of time and distance give her an average speed, from the time she cleared the harbor mouth until the time she was run ashore at Rio Tarquino, of 13·7 knots. Neither the "New York" nor the "Brooklyn" stopped to couple up their forward engines, but ran out the chase with one pair, getting steam, of course, as rapidly as possible on all boilers. To stop to couple up the forward engines would have meant a delay of fifteen minutes, or four miles in the chase.

14. Several of the ships were struck, the "Brooklyn" more often than the others, but very slight material injury was done, the greatest being aboard the "Iowa." Our loss was one man killed and one wounded, both on the "Brooklyn." It is difficult to explain this immunity from loss of life or injury to ships in a combat with modern vessels of the best type; but Spanish gunnery is poor at best, and the superior weight and accuracy of our fire speedily drove the men from their guns and silenced their fire. This is borne out by the statements of prisoners and by observation. The Spanish vessels, as they dashed out of the harbor, were covered with the smoke from their own guns, but this speedily diminished in volume, and soon almost disappeared. The fire from the rapid-fire batteries of the battleships appears to have been remarkably destructive. An examination of the stranded vessels shows that the "Almirante Oquendo" especially had suffered terribly from this fire. Her sides are everywhere pierced, and her decks were strewn with the charred remains of those who had fallen.

15. The reports of Commodore W. S. Schley and of the commanding officers are inclosed.

16. A board, appointed by me several days ago, has made a critical examination of the stranded vessels, both with a view of reporting upon the result of our fire and the military features involved, and of reporting upon the chance of saving any of them and of wrecking the remainder. The report of the board will be speedily forwarded.

Very respectfully,

W. T. SAMPSON,
Rear Admiral, U. S. N.,
Commander-in-Chief, United States Naval Force,
North Atlantic Station.

The Secretary of the Navy,
Navy Department, Washington, D. C.

COMMODORE SCHLEY'S REPORT.

North Atlantic Fleet, Second Squadron,
U. S. Flagship "Brooklyn,"
Guantanamo Bay, Cuba, July 6, 1898.

Sir: 1. I have the honor to make the following report of that part of the squadron under your command which came under my observation during the engagement with the Spanish fleet on July 3, 1898.

2. At 9:35 A. M. Admiral Cervera, with the "Infanta Maria Teresa," "Vizcaya," "Oquendo," "Cristobal Colon," and two torpedo-boat destroyers, came out of the harbor of Santiago de Cuba in column at distance and attempted to escape to the westward. Signal was made from the "Iowa" that the enemy was coming out, but this movement had been discovered from this ship at the same moment. This vessel was the farthest west, except the "Vixen," in the blockading line. Signal was made to the western division as prescribed in your general orders, and there was immediate and rapid movement inward by your squadron and a general engagement at ranges beginning at eleven hundred yards and varying to three thousand, until the "Vizcaya" was destroyed, about 10:50 A. M. The concentration of the fire of the squadron upon the ships coming out was most furious and terrific and great damage was done them.

3. About twenty or twenty-five minutes after the engagement began, two vessels, thought to be the "Teresa" and "Oquendo," and since verified as such, took fire from the effective shell fire of the squadron and were forced to run on the beach some six or seven miles west of the harbor entrance, where they burned and blew up later. The torpedo-boat destroyers were destroyed early in the action, but the smoke was so dense in their direction that I cannot say to which vessel or vessels the credit belongs. This, doubtless, was better seen from your flagship.

4. The "Vizcaya" and "Colon," perceiving the disaster to their consorts, continued at full speed to the westward to escape, and were followed and engaged in a running fight with the "Brooklyn," "Texas," "Iowa," and "Oregon" until 10:50, when the "Vizcaya" took fire from our shells. She put her helm to port, and, with a heavy list to port, stood in shore and ran aground at Aserradero, about twenty-one miles west of Santiago, on fire fore and aft, and where she blew up during the night. Observing that she had struck her colors and that several vessels were nearing her to capture and save the crew, signal was made to cease firing. The "Oregon," having proved vastly faster than the other battleships, she and the "Brooklyn," together with the "Texas" and another vessel, which proved to be your flagship, continued westward, in pursuit of the "Colon," which had run close in shore, evidently seeking some good spot to beach, if she should fail to elude her pursuers.

5. This pursuit continued with increasing speed in the "Brooklyn," "Oregon" and other ships, and soon the "Brooklyn" and the "Oregon" were within long range of the "Colon," when the "Oregon" opened fire with her 13-inch guns, landing a shell close to the "Colon." A moment afterward the "Brooklyn" opened fire with her 8-inch guns, landing a shell just ahead of her. Several other shells were fired at the "Colon," now in range of the "Brooklyn's" and "Oregon's" guns. Her commander seeing all chances of escape cut off and destruction awaiting his ship, fired a lee gun and struck her flag at 1:15 P. M., and ran ashore at a point some fifty miles west of Santiago Harbor. Your flagship was coming up rapidly at the time, as was also the "Texas" and "Vixen." A little later, after your arrival, the "Cristobal Colon," which had struck to the "Brooklyn" and the "Oregon," was turned over to you as one of the trophies of this great victory of the squadron under your command.

6. During my official visit a little later Commander Eaton, of the "Resolute," appeared and reported to you the presence of a Spanish battleship near Altares. Your orders to me were to take the "Oregon" and go eastward to meet her, and this was done by the "Brooklyn," with the result that the vessel reported as an enemy was discovered to be the Austrian cruiser "Infanta Maria Teresa" seeking the commander-in-chief.

7. I would mention for your consideration that the "Brooklyn" occupied the most westward blockading position with the "Vixen," and being more directly in the route taken by the Spanish squadron, was exposed for some minutes, possibly ten, to the gun fire of three of the Spanish ships and the west battery at a range of 1,500 yards from the ships and about 3,000 yards from the batteries, but the vessels of the entire squadron, closing in rapidly, soon diverted this fire and did magnificent work at close range. I have never before witnessed such deadly and fatally accurate shooting as was done by the ships of your command as they closed in on the Spanish squadron, and I deem it a high privilege to commend to you for such action as you may deem proper, the gallantry and dashing courage, the prompt decision and the skillful handling of their respective vessels, of Capt. Philip, Capt. Evans, Capt. Clark, and especially of my chief of staff, Capt. Cook, who was directly under my personal observation and whose coolness, promptness, and courage were of the highest order. The dense smoke of the combat shut out from my view the "Indiana" and the "Gloucester," but as these vessels were closer to your flagship, no doubt their part in the conflict was under your immediate observation.

8. Lieut. Sharp, commanding the "Vixen," acted with conspicuous courage; although unable to engage the heavier ships of the enemy with his light guns, nevertheless was close into the battle line under heavy fire, and many of the enemy's shot passed beyond his vessel.

9. I beg to invite special attention to the conduct of my flag lieutenant, James H. Sears, and Ensign Edward McCauley, Jr., aide, who were constantly at my side during the engagement, and who exposed themselves fearlessly in discharging their duties; and also to the splendid behavior of my secretary, Lieut. B. W. Wells, Jr., who commanded and directed the fighting of the fourth division with splendid effect.

10. I would commend the highly meritorious conduct and courage in the engagement of Lieut.-Commander N. E. Mason, the executive officer, whose presence everywhere over the ship during its continuance did much to secure the good result of this ship's part in the victory.

11. The navigator, Lieut. A. C. Hodgson, and the division officers, Lieut. T. D. Griffin, Lieut. W. R. Rush, Lieut. Edward Simpson, Lieut. J. G. Doyle, Ensign Charles Webster, and the junior divisional officers were most steady and conspicuous in every detail of duty, contributing to the accurate firing of this ship in her part of the great victory of your forces.

12. The officers of the medical, pay, and engineer and marine corps responded to every demand of the

occasion and were fearless in exposing themselves. The warrant officers, Boatswain William L. Hill, Carpenter G. H. Warford, and Gunner F. T. Applegate, were everywhere exposed in watching for damage, reports of which were promptly conveyed to me.

13. I have never in my life served with a braver, better, or worthier crew than that of the "Brooklyn." During the combat, lasting from 9:35 until 1:15 P. M., much of the time under fire, they never flagged for a moment and were apparently undisturbed by the storm of projectiles passing ahead, astern, and over the ship.

14. The result of the engagement was the destruction of the Spanish squadron and the capture of the admiral and some thirteen to fifteen hundred prisoners, with the loss of several hundred killed, estimated by Admiral Cervera at 600 men.

15. The casualties on board this ship were: G. H. Ellis, chief yeoman, killed; J. Burns, fireman, first class, severely wounded. The marks and scars show that the ship was struck about twenty-five times, and she bears in all forty-one scars as the result of her participation in the great victory of your forces on July 3, 1898. The speed-cone halliards were shot away, and nearly all the signal halliards. The ensign at the main was so shattered that in hauling it down at the close of the action, it fell in pieces.

16. I congratulate you most sincerely upon this great victory to the squadron under your command, and I am glad that I had an opportunity to contribute in the least to a victory that seems big enough for all of us.

17. I have the honor to transmit herewith the report of the commanding officer and a drawing in profile of the ship showing the location of hits and scars; also a memorandum of the ammunition expended and the amount to fill her allowance.

18. Since reaching this place and holding conversation with several of the captains, viz., Capt. Eulate, of the "Vizcaya," and the second in command of the "Colon," Commander Contreras, I have learned that the Spanish admiral's scheme was to concentrate all fire for a while on the "Brooklyn," and the "Vizcaya" to ram her, in hopes that if they could destroy her, the chance of escape would be increased, as it was supposed she was the swiftest ship of your squadron. This explains the heavy fire mentioned and the "Vizcaya's" action in the earlier moments of the engagement. The execution of this purpose was promptly defeated by the fact that all of the ships of the squadron advanced into close range and opened an irresistibly furious and terrific fire upon the enemy's squadron as it was coming out of the harbor.

19. I am glad to say that the injury supposed to be below the water line was due to a water valve being opened from some unknown cause and flooding the compartment. The injury to the belt is found to be only slight and the leak small.

20. I beg to inclose a list of the officers and crew who participated in the combat of July 3, 1898.

21. I cannot close this report without mentioning in high terms of praise the splendid conduct and support of Capt. C. E. Clark, of the "Oregon." Her speed was wonderful and her accurate fire splendidly destructive.

Very respectfully, W. S. SCHLEY,
(Signed) Commodore United States Navy,
Commanding Second Squadron, North Atlantic Fleet.
The Commander-in-Chief, United States Naval Force, North Atlantic Station.

REPORT OF CAPT. EVANS, OF THE "IOWA."

U. S. S. "Iowa," First Rate,
Off Santiago de Cuba, Cuba,
July 4, 1898.

Sir: I have the honor to make the following report of the engagement with the Spanish squadron off Santiago de Cuba on the 3d of July;

1. On the morning of the 3d, while the crew was at quarters for Sunday inspection, the leading vessel of the Spanish squadron was sighted at 9:31 coming out of the harbor of Santiago de Cuba. Signal "Enemy's ships coming out" was immediately hoisted, and a gun fired to attract attention. The call to general quarters was sounded immediately, the battery was ready for firing, and the engines rung full speed.

2. The position of this vessel at the time of sighting the squadron was the usual blockading station off the entrance of the harbor, Morro Castle bearing about north and distant about three to four miles. The steam at this time in the boilers was sufficient for a speed of five knots.

3. After sighting the leading vessel, the "Infanta Maria Teresa" (Admiral Cervera's flagship), it was observed that she was followed in succession by the remaining three vessels of the Spanish squadron, the "Vizcaya," "Cristobal Colon," and "Almirante Oquendo." The Spanish ships moved at a speed of about 8 to 10 knots, which was steadily increased as they cleared the harbor entrance and stood to the westward. They maintained a distance of about 800 yards between vessels. The squadron moved with precision and stations were well kept.

4. Immediately upon sighting the leading vessel fires were spread and the "Iowa" headed toward the leading Spanish ship. About 9:40 the first shot was fired from this ship at a distance of about 6,000 yards. The course of this vessel was so laid that the range speedily diminished. A number of shots were fired at ranges varying between 6,000 and 4,000 yards. The range was rapidly reduced to 2,500 yards and subsequently to 2,000 and to 1,200 yards.

5. When it was certain that the "Maria Teresa" would pass ahead of us, the helm was put to the starboard and the starboard broadside delivered at a range of 2,500 yards. The helm was then put to port and the ship headed across the bow of the second ship, and as she drew ahead the helm was again put to starboard and she received in turn the full weight of our starboard broadside at a range of about 1,800 yards. The "Iowa" was again headed off with the port helm for the third ship, and as she approached the helm was put to starboard until our course was approximately that of the Spanish ship. In this position, at a range of 1,400 yards, the fire of the entire battery, including rapid-fire guns, was poured into the enemy's ships.

6. About 10 o'clock the enemy's torpedo-boat destroyers "Furor" and "Pluton" were observed to have left the harbor and to be following the Spanish squadron. At the time that they were observed, and, in fact, most of the time that they were under fire, they were at a distance varying from 4,500 to 4,000 yards. As soon as they were discovered, the secondary battery continued to engage the "Vizcaya," "Oquendo," and "Maria Teresa." The fire of the main battery of this ship when the range was below 2,500 yards was most effective and destructive, and after a continuance of this fire for perhaps twenty minutes it was noticed that the "Maria Teresa" and "Oquendo" were in flames and were being headed for the beach. Their colors were struck about 10:20 and they were beached about eight miles west of Santiago.

7. About the same time (about 10:25) the fire of this vessel, together with that of the "Gloucester" and another smaller vessel, proved so destructive that one of the torpedo-boat destroyers ("Pluton") was sunk, and the "Furor" was so much damaged that she was run upon the rocks.

8. After having passed, at 10:35, the "Oquendo" and "Maria Teresa," on fire and ashore, this vessel continued to chase and fire upon the "Vizcaya" until 10:36, when signal to cease firing was sounded on board, it having been discovered that the "Vizcaya" had struck her colors.

9. At 11 the "Iowa" arrived in the vicinity of the "Vizcaya," which had been run ashore, and it was evident that she could not catch the "Cristobal Colon" and that the "Oregon," "Brooklyn," and "New York" would. Two steam cutters and three cutters were immediately hoisted out and sent to the "Vizcaya" to rescue her crew. Our boats succeeded in bringing off a large number of officers and men of that ship's company, and in placing many of them on board the torpedo-boat "Ericsson" and the auxiliary dispatch vessel "Hist."

10. About 11:30 the "New York" passed in chase of the "Cristobal Colon," which was endeavoring to escape from the "Oregon," "Brooklyn," and "Texas."

11. We received on board this vessel from the "Vizcaya," Capt. Eulate, the commanding officer, and twenty-three officers, together with 248 petty officers and men, of whom thirty-two were wounded. There were also received on board five dead bodies, which were immediately buried with the honors due to their grade.

12. The battery behaved well in all respects, the dash-pot of the forward 13-inch gun, damaged in the engagement of the 2d, having been replaced the same day by one of the old dash-pots, which gave no trouble during this engagement.

13. The following is an approximate statement of the ammunition expended during the engagement. A more exact statement cannot be given at this time: 31 12-inch semi A. P. shells with full charges; 35 8-inch common shell, with full charges; 251 4-inch cartridges, common shell; 1,056 6-pounder cartridges, common shell; 100 1-pounder cartridges, common shell.

14. This ship was struck in the hull, on the starboard side, during the early part of the engagement by two projectiles of about six-inch caliber, one striking the hull two to three feet above the actual water-line and almost directly on the line of the berth deck, piercing the ship's side between the frames 9 and 10, and the other piercing the side and the coffer-dam between frames 18 and 19. The projectile did not pass beyond the inner bulkhead of the coffer-dam A 41-43. The hole made by it was large and ragged, being about sixteen inches in a longitudinal direction and about seven inches in a vertical direction. It struck with a slight inclination aft, and perforated the coffer-dam partition bulkhead (A 43, 45, 47). It did not explode, and remained in the coffer-dam. The second projectile pierced the side of the ship and the coffer-dam A 105, the upper edge of the hole being immediately below the top of the coffer-dam on the berth deck, in compartment A 104. The projectile broke off the hatch-plate and coaming of the water-tank compartment, exploded, and perforated the walls of the chain locker. The explosion created a small fire, which was promptly extinguished. The hole in the side made by this projectile was about five feet above the water-line and about two to three feet above the berth deck. One fragment of this shell struck a link of the sheet chain, wound around the six-pounder ammunition hoist, cutting the link in two. Another perforated the coffer-dam on the port side, and slightly dished the outside plating. These two wounds, fortunately, were not of serious importance. Two or three other projectiles of small caliber struck about the upper bridge and smoke-stacks, inflicting trifling damage, and four other small projectiles struck the hammock nettings and the side aft.

15. There are no casualties among the ship's company to report. No officer or man was injured during the engagement.

16. After having received on board the rescued crew of the "Vizcaya," this vessel proceeded to the eastward and resumed the blockading station in obedience to the signal made by the commander-in-chief about 11:30.

17. Upon arriving on the blockading station, the "Gloucester" transferred to this vessel Rear Admiral Cervera, his flag lieutenant, and commanding officers of the torpedo boat destroyers "Furor" and "Pluton;" and also one man of the "Oquendo's" crew, rescued by the "Gloucester."

18. Naval Cadets Frank Taylor Evans and John E. Lewis and five men belonging to the "Massachusetts" were on board the "Iowa" when the enemy's ships came out. They were stationed at different points and rendered efficient service.

19. The officers and men of this ship behaved admirably. No set of men could have done more gallant service. I take great pleasure in stating to you, sir, that the coolness and judgment of the executive officer, Lieut.-Commander Raymond P. Rodgers, deserve and will, I hope, receive a proper reward at the hands of the government. The test of the executive officer's work is the conduct of the ship and crew in battle—in this case it was simply superb. The coolness of the navigator, Lieut. W. H. Schuetzo, and of Lieut. F. K. Hill, in charge of the rapid-fire guns on the upper deck, are worthy of the greatest commendation. Other officers of the ship did not come under my personal observation, but the result of the action shows how well they did their duty.

I cannot express my admiration for my magnificent crew. So long as the enemy showed his flag, they fought like American seamen; but when the flag came down, they were as gentle and tender as American women.

20. In conclusion, sir, allow me to congratulate you on the complete victory achieved by our fleet.

Very respectfully,
R. D. EVANS,
Captain U. S. Navy, Commanding.
To the Commander-in-Chief, U. S. Naval Force, North Atlantic Station.

REPORT OF CAPT. CLARK, OF THE "OREGON."

U. S. S. "Oregon," First Rate,
Off Santiago de Cuba,
July 4, 1898.

Sir: 1. I have the honor to report that, at 9:30 A. M., yesterday, the Spanish fleet was discovered standing out of the harbor of Santiago de Cuba. They turned to the westward and opened fire, to which our ships replied vigorously. For a short time there was an almost continuous flight of projectiles over this ship, but when our line was fairly engaged, and the "Iowa" had made a swift advance as if to ram or close, the enemy's fire became defective in train as well as range. The ship was only struck three times, and at least two of them were by fragments of shells. We had no casualties.

2. As soon as it was evident that the enemy's ships were trying to break through and escape to the westward, we went ahead at full speed with the determination of carrying out to the utmost your order: "If the enemy tries to escape, you must close and engage as soon as possible and endeavor to sink his vessels or force them to run ashore." We soon passed all our ships except the "Brooklyn," bearing the broad pennant of Commodore Schley. At first we only used our main battery, but when it was discovered that the enemy's torpedo boats were following our ships, we used our rapid-firing guns as well as the six-inch upon them with telling effect. As we ranged up near the sternmost of their ships she headed for the beach, evidently on fire. We raked her as we passed, pushing on for the next ahead, using our starboard guns as they were brought to bear, and before we had passed her fairly abeam she, too, was making for the beach. The two remaining vessels were now some distance ahead, but our speed had increased to sixteen knots, and our fire, added to that of the "Brooklyn," soon sent another, the "Vizcaya," to the shore in flames. Only the "Cristobal Colon" was left, and for a time it seemed as if she might escape, but when we opened with our forward turret guns, and the "Brooklyn" followed, she began to edge in toward the coast, and her capture or destruction was assured. As she struck the beach her flag came down, and the "Brooklyn" signaled "Cease firing," following it with "Congratulations for the grand victory, thanks for your splendid assistance."

3. The "Brooklyn" sent a boat to her, and when the admiral came up with the "New York" and "Texas" and "Vixen" she was taken possession of. A prize crew was put on board from this ship under Lieut. Cogswell, the executive officer, but before 11 P. M., the ship, which had been filling in spite of all efforts to stop leaks, was abandoned, and just as the crew left she went over on her side.

4. I cannot speak in too high terms of the bearing and conduct of all on board this ship. When they found the "Oregon" had pushed to the front and was hurrying to a succession of conflicts with the enemy's vessels, if they could be overtaken and would engage, their enthusiasm was intense.

5. As these vessels were so much more heavily armored than the "Brooklyn," they might have concentrated upon and overpowered her, and consequently I am persuaded that, but for the way her officers and the men of the "Oregon" steamed and steered the ship, and fought and supplied her batteries, the "Colon" and perhaps the "Vizcaya" would have escaped. Therefore, I feel that they rendered meritorious service to the country, and while I cannot mention the name of each officer and man individually, I am going to append a list of the officers, with the stations that they occupied, hoping that they may be of service to them should the claims of others for advancement above them ever be considered.

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Very respectfully,
C. E. CLARK,
Captain, U. S. Navy, Commanding.
The Commander-in-Chief, U. S. Naval Force, North Atlantic Station.

REPORT OF LIEUT.-COMMANDER WAINWRIGHT, OF THE "GLOUCESTER."

U. S. S. "Gloucester,"
Off Santiago de Cuba, July 6, 1898.

Sir: I have the honor to report that at the battle of Santiago on July 3 the officers and crew of the "Gloucester" were uninjured and the vessel was not injured in hull or machinery, the battery only requiring some slight overhauling. It is now in excellent condition.

2. I inclose herewith a copy of the report of the executive officer, made in compliance with paragraph 325, page 110, Naval Regulations, which report I believe to be correct in all particulars. I also inclose copies of the reports of the several officers, which may prove valuable for future reference.

3. It was the plain duty of the "Gloucester" to look after the destroyers, and she was held back, gaining steam, until they appeared at the entrance. The "Indiana" poured in a hot fire from all her secondary battery upon the destroyers; but Capt. Taylor's signal "Gunboats close in" gave security that we would not be fired upon by our own ships. Until the leading destroyer was injured our course was converging, necessarily; but as soon as she slackened her speed, we headed directly for both vessels, firing both port and starboard batteries as the occasion offered.

4. All the officers and nearly all the men deserve my highest praise during the action. The escape of the "Gloucester" was due mainly to the accuracy and rapidity of the fire. The efficiency of this fire, as well as that of the ship generally, was largely due to the intelligent and unremitting efforts of the executive officer, Lieut. Harry P. Huse. The result is more to his credit when it is remembered that a large propor-

tion of the officers and men were untrained when the "Gloucester" was commissioned. Throughout the action he was on the bridge and carried out my orders with great coolness. That we were able to close in with the destroyers—and until we did so they were not seriously injured—was largely due to the skill and constant attention of Passed Assistant Engineer George W. McElroy. The blowers were put on and the speed increased to seventeen knots without causing a tube to leak or a brass to heat. Lieut. Thomas C. Wood, Lieut. George H. Norman, Jr., and Ensign John T. Edson not only controlled the fire of the guns in their divisions and prevented waste of ammunition, but they also did some excellent shooting themselves. Acting Assistant Surgeon J. F. Bransford took charge of one of the guns and fired it himself occasionally. Acting Assistant Paymaster Alexander Brown had charge of the two Colt guns, firing one himself, and they did excellent work. Assistant Engineer A. M. Proctor carried my orders from the bridge, and occasionally fired a gun when I found it was not being served quite satisfactorily. All were cool and active at a time when they could have had but little hope of escaping uninjured.

5. Lieuts. Wood and Norman, Ensign Edson and Assistant Engineer Proctor were in charge of the boats engaged in saving life. They all risked their lives repeatedly in boarding and remaining near the two destroyers and the two armored cruisers when their guns were being discharged by the heat and their magazines and boilers were exploding. They also showed great skill in landing and taking off the prisoners through the surf.

6. Of the men mentioned in the several reports, I would call special attention to John Bond, chief boatswain's mate. He would have been recommended to the department for promotion prior to his gallant conduct during the action of July 3. I would also recommend to your attention Robert P. Jennings, chief machinist, mentioned in the report of Mr. McElroy. I believe it would have a good effect to recognize the skill of the men and the danger incurred by the engineer's force. I would also recommend that the acting appointments of those men mentioned by the officers in their reports be made permanent.

7. The wounded and exhausted prisoners were well and skillfully tended by Assistant Surgeon Bransford, assisted by Ensign Edson, who is also a surgeon.

8. The admiral, his officers and men, were treated with all the consideration and care possible. They were fed and clothed as far as our limited means would permit.

Very respectfully,

RICHARD WAINWRIGHT,

Lieutenant-Commander, U. S. N., Commanding.

To the Commander-in-Chief, U. S. Naval Forces, North Atlantic Station.

TORONTO MAGNETIC OBSERVATORY.*

By R. F. STUPART.

THE importance of obtaining a correct knowledge of the elementary facts of terrestrial magnetism, for the purpose of supplying a foundation whereon the advancement of that science on inductive principles may be based, has for long been strongly and extensively felt.

From an early period of the meetings of the British Association for the Advancement of Science, the interest of terrestrial magnetism had received no inconsiderable share of the attention and exertions of its members. In the year 1834 a magnetic survey of the British Isles was commenced and carried through in the two following years by the joint labors of five of its members. In 1835 the association called for a report from one of its members, on the state and progress of researches regarding the geographical distribution of the magnetic forces on the surface of the globe, proposing to ground on the preliminary examination an application to the government to aid in the prosecution of the inquiry in remote parts of the earth, unattainable by the means at the command of the association itself, or of its individual members. This report, presented in 1837, was taken into consideration at the meeting of the association at Newcastle, in 1838, and a memorial was addressed to the government, which, being favorably received by her Majesty's ministers, originated the naval expedition equipped in the following year for a magnetic survey of the high latitudes of the southern hemisphere. Deeming the opportunity a fitting one, the British Association availed itself of the same occasion to solicit the attention of her Majesty's government to the expediency of extending the researches to be accomplished by fixed observatories to certain stations of prominent magnetic interest within the limits of the British colonial dominions. The stations named were Canada and Van Diemen's Land, as approximate to the points of the greatest intensity of the magnetic force in the northern and southern hemispheres; St. Helena, as approximate to the point of least intensity on the globe, and the Cape of Good Hope as a station where the secular changes of the magnetic elements presented features of peculiar interest.

The committee recommended that the proposed colonial establishments should be placed under the general supervision of the Ordnance Department of the army. The government having expressed a desire that such extensive arrangement, involving a considerable expenditure, should be strengthened by the concurrent support of the Royal Society, a deputation was appointed to express the cordial participation of that society in the recommendation both of the naval expedition and of the fixed observatories. Arrangements having been completed, Lieutenant Charles James Buchanan Riddell, R.A., was selected for duty in Canada, who, leaving his detachment, consisting of four non-commissioned officers of the artillery, to embark with the instruments on a vessel bound direct to Quebec, proceeded himself to Canada by the more expeditious route of the United States, and having waited on the governor-general at Montreal to present a letter of introduction with which he had been furnished by the master-general of the ordnance, and communicated with the commanding engineer, to whom he was the bearer of instructions and authority to build an observatory, he proceeded to examine different localities which were suggested as convenient sites. The preference was finally given to Toronto,* where a grant of 2½ acres of land belonging to the University of King's College was offered by the council of the University. The first observatory building was of logs, roughcast on the outside and plastered on the inside; it was completed during the summer of 1840 and observations were begun in September. The operations of the observatory as an imperial establishment were brought to a close in the early part of the year 1853, and were resumed under the authority of the provincial government in July of the same year.

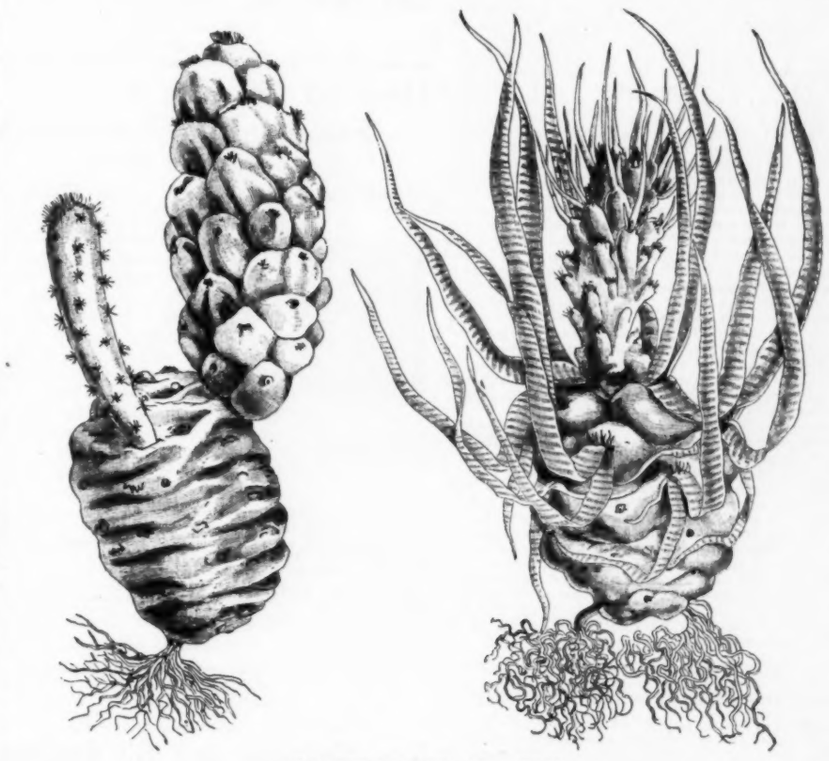
In the autumn of 1853 the present observatory was commenced, to take the place of the old building. Very great care was taken during construction to insure all the stone used being entirely free from magnetism, and all nails and fastenings were of either copper or zinc. For 23 years the position of the observatory was, as far as is known, faultless, and observations were carried on systematically and carefully, and results given to the scientific world which, with those obtained under the old military regime, have made the Toronto Observatory famous in the history of terrestrial magnetism.

In 1876, however, trouble began with the building of the School of Science, which institution, however, being principally of brick and wood, caused but very small changes in zero values, which could be allowed for. Then followed a few years later electric-light circuits which produced a change in the force instruments whenever the current was turned off or on; this difficulty was in part overcome by the light company courteously agreeing to arrange its wires in the vicinity of the observatory in such a manner that currents should counteract each other. The next difficulty occurred when the addition was given to the School of Science, tons of iron being used in the construction of that building in an all too-close proximity to the magnetic instruments, and much time and labor have been required to determine the precise effect of this "iron mine" on the various instruments. It was not, however, until the autumn of 1892, when the trolleys began to run, that we began to suspect that sooner or later the Magnetic Observatory would have to be removed to another site.

The magnetic instruments in the observatory consist of those brought out by Lieutenant Riddell in 1840, of which eye readings have been taken six times each day, and of another set of similar instruments, consisting of a bifilar, for the measurement of the horizontal component, a balance needle for the vertical force, and a declinometer, all of which record photographically.

Electric cars first ran in Toronto on August 17, 1892; the line first put in operation was that on Church street, which was followed on September 5 by King street, between George street and Dufferin street. During the first few weeks, while a very small vibration of the needle was discernible on the v. f. curve, it was generally almost inappreciable, and it was not until September 20 that the movement increased to an extent sufficient to really impair the value of our magnetic curves; a marked increase of current must have been used on that day and afterward. On October 10 the cars first ran on Yonge street, and there was only a very small increase in vibration, but a decrease of about 0·000070 of a dyne was observed when the current was on. About 10 A. M., on January 14, there was a marked increase of vibration and the vertical force increased about 0·000200 one dyne. This disturbed period was only temporary, and shortly after 5 P. M. of the 17th there was a reversion to the smaller vibrations, which continued until May 15, when very large vibrations began again and continued with varying intensity during the summer, while the decrease of the v. f. with the current ranged from about 0·000200 to 0·000500. This disturbance was very great between September 12 and October 17 and at intervals during the following year, but there was no radical change in conditions until December 17, 1894, when a decrease of v. f. while the current was on was changed to an increase, this occurring when the cars first ran on McCaul street. Throughout 1895, the vibration and amount of permanent deflection were very nearly as they have been since, but, on October 15, the increase of v. f. with the current was again changed to a decrease. This occurred at the time that the railway company made certain changes in the feed wires. It is noticeable that, although several changes occured in the v. f., it at times has been less with the current on and at other times greater. The horizontal force showed a steady decrease on all occasions with the turn on of the current, which during the past two years has been 0·000200 to 0·000500. No appreciable deflection of the declinometer magnet can be noted, the only effect being a continuous vibration which has rendered the curves very ragged and difficult to read with accuracy.

A study of the traces during the times that the various electric lines were put in operation shows that with the currents ordinarily used there is little effect at three-fourths mile, and a further survey with a portable instrument affords further evidence in the same direction; it has, therefore, been determined to remove the magnetic instruments to a point distant two miles from any probable trolley route and about nine miles from the present location, and continue what are certainly the most valuable and extended magnetic records outside of Europe.



PAPERY-SPINED OPUNTIAS.

1. Opuntia papyracantha. 2. A form of Opuntia papyracantha.

PAPERY-SPINED OPUNTIAS.

THE genus Opuntia, as at present constituted, comprises about 150 species, two-thirds of which are natives of North America, the other third being scattered over South America and the West Indies. Its great variety of forms are separated into two groups, viz., flat-branched (Platopontia), represented by the common Indian fig and cylinder-branched (Cylindropuntia), of which O. arborescens is an example. Most of the latter group are remarkable in having a loose papery sheath over each of their large spines, the tip of the spine projecting slightly through an opening at the top. O. tunicata, of which good examples may be seen at Kew, is one of the commonest of this group.

There are about half a dozen species, all natives of the Argentine Republic, which differ from all other Opuntias in having long, flat, paper-like "spines" springing from among the tufts of short bristles which crown each of the hump-like tubercles of the stem. These are known as the broad-spined Opuntias (Platyacanthæ), and several of them are in cultivation under such names as O. Turpini, O. diademata, and O. glomerata. Very little appears to be known about them, even to botanists, and so far as I know they never flower under cultivation. The most striking of the species of this group is that represented in the illustration, taken from a specimen which has lately been added to the Kew collection through the kindness of Señor Douglas Junor, of Floresta, Buenos Ayres, a dealer in Cactaceæ. He calls it O. plumosa nivea, but it is, no doubt, the O. papyracantha of Philippi, a native of the Argentine Cordilleras.

The plant figured has gray-green, ovate branches, 2 to 3 inches long, the surface broken into broad tubercles, ¾ inch apart, each crowned with a dense, brush-

*From The Canadian Engineer.

*The history of the establishment of the observatory at Toronto is taken from the early reports.

like tuft of short brown bristles, and two or three suberect, flat, thin, cartilaginous, paper white appendages, which are neither leaves nor spines nor sheaths, but probably modifications of the latter, the spines they once covered having been suppressed. These appendages are from 1 to 3 inches long, ¼ inch wide at the base, tapering to a fine point, the margins more or less ragged. The plant at Kew is thriving in a tropical house, and it looks as if it will not be difficult to manage. The plant numbered 2 in figure appears to be a form of O. papyracantha without the paper-like spines. —The Gardeners' Chronicle.

PALM KERNELS—A NEW INDUSTRY.

THE crushing of seeds and nuts for the oil which they contain and the preparation of feeding stuffs from the residue is, so far as England is concerned, a comparatively new industry. And one of the most important phases of this business is that which centers round the products of the oil palm, and plays such a considerable part in the trade between the West Coast of Africa and Liverpool. This palm—a beautiful tree of the umbrella pattern—flowers about September or October, and the fruit ripens about four or five months afterward, the main crop being gathered from February to May. The fruit is gathered by natives, who ascend the trees by means of ropes—sailor fashion—and detach the masses of nut clusters, or "hands" as they are called, with a small ax or cutlass. The nuts are then heaped on the ground, covered with palm leaves, and left for a week in the hot and more or less moist atmosphere to ferment. During this process the nuts become loose in their sockets, and are removed by hand and placed in baskets. The next processes aim at the separation of the nut proper from the seed vessel or pericarp. First, huge earthenware pots are taken, with a capacity of about 12 or 14 gallons, and in these are placed about half a hundredweight of nuts. Water is added and the pot placed over a slow wood fire. After two hours' boiling the seed vessel is sufficiently soft to be squeezable by the fingers. The nuts are then placed in the bottom of a canoe drawn up on the river bank, and the natives tread out the nuts from the encircling pericarp with their bare feet. Three men will thus tread out 250 pounds in an hour. Water is then poured into the canoe to a depth of 3 to 4 inches, and the nuts treated to the final separating process by being rocked, stirred, and shaken. By this means the kernels with the hard shell containing them become detached from the pericarp, and after drying in the sun are cracked between stones so as to separate the "palm kernels" of commerce from the hard shell inclosing them. But the water in the canoe has become covered with a yellowish oily scum. This is carefully collected in calabashes, and the pericarp fiber is squeezed and washed, and finally pressed in a mortar to extract the remaining particles of oil, and being of no further commerical value, is thrown aside to be used as fuel. Thus, the West African negroes supply us from the oil palm with two valuable articles of commerce—palm oil and palm kernels. The processes employed are wasteful, no doubt, and the absence of means of communication, save by the rivers and creeks, implies that many thousands of tons of precious produce are annually allowed to rot. This waste, however, is gradually being reduced, and with the advent of much required railways, our supplies of West African tropical produce must be increased indefinitely. The bulk of the palm kernels—or rather that section of them shipped to England—find their way to Liverpool, and it certainly did not reflect creditably upon the enterprise of the merchants of the Mersey port that the major portion of such imports also figured in the exports or transshipments from Liverpool to Continental ports.—The Syren.

GLAZED PAPER AND THE EYESIGHT.

THE effect of glazed papers on the eyesight has recently occupied the attention of some German doctors, says The Druggist's Circular. One authority examines the causes of the changes in the general reading and writing habits of the nation, and explains that in the earlier part of the century the old rag papers then in use both for writing and printing purposes were mostly of a dull gray or blue color, and were coarse-grained, so that thick letters had to be used by writers with quill pens or by printers on their old slow presses. With the introduction of more modern fibers, paper received a smoother surface, steel pens could be employed, and the printing paper could travel over quicker printing presses.

The fashion for brilliant colors and elaborate type setting has been carried to such a state of perfection that a reflection is often created which could never arise from the former rougher surface. Now, what is the effect upon the reader's eye? In the old books or letters, with a mild and soothing light, the surface contrasted easily from the thicker and darker type or writing characters; now the highly glazed surface offers reflections of the light which, with the more elaborate and thinner type, produces a lot of shades and lights which are most trying to the eye. The paper has often to be turned in various directions to be seen more clearly in order to distinguish the gray (or may be other shades) of the type from the shining white of the paper. This is similar in effect, as to the result, of trying to decipher writing in the dusk. An experiment would soon prove this.

Take an old edition, say of Shakespeare, and a new magazine on highly glazed paper and compare the sensation in the eye after half an hour's reading. The doctors, therefore, propose that the public inspectors of schools should order the use of sanitary paper for the eyes, by which they mean that a glazed or highly polished surface should be avoided, and the colors chosen should rather be gray or light blue, but no white, and, in fact, no brilliant colors at all. The type should be clear and simple, and not too thin.

The children, whose eyes require protection, and through them the parents, should be taught to demand their favorite books and papers to be printed in the right style, and the excesses of a falsely guided taste should be avoided. It is suggested that a few years of such policy would soon improve the eyesight.

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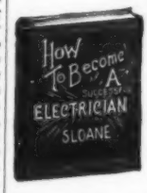

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